August 1970

Smithsonian

Head of a 1718 *viola da gamba* that is still played

August 1970

Smithsonian

Volume 1, Number 5

Secretary of Smithsonian Institution
S. Dillon Ripley

Chairman of Smithsonian National Associates
Thomas J. Watson jr.

Editor
Edward K. Thompson

Board of Editors
Ralph Backlund, Hobart Ellis, Edwards Park

Associate Editor Grayce Northcross

Assistant Editors Caroline Despard,
Sally Ann Scott, Judith Tripp

Art Direction John Beveridge

Advertising Director Thomas H. Black

General Manager Joseph Bonsignore

Circulation-Promotion Director
Anne Keating

Consultants Bradbury Thompson, design
Arthur R. Murphy jr., publishing

Picture Credits

Cover Lee Boltin; 3 Smithsonian Institution;
4, 5 Lee Boltin; 6 drawing by Beveridge & Associates;
7 Georg Andreas Boeckler, *Theatrum Machinarum Novum;*
9-11 Lee Boltin; 12-15 Alfred Eisenstaedt; 16, 17
Col. John M. Geary; 18 map by Paul Salmon; 19-23
Col. John M. Geary; 25-31 Dill Cole; 32-35 Henry
B. Weaver; 37-41 © 1970 Lee Boltin; 42 Francis M. Greenwell;
44- 45 drawings by Arthur D. Cushman; 47 Francis M.
Greenwell; 49 Charles Phillips; 50, 51 Robert de Gast; 52-53
Lee Boltin; 54 Smithsonian Institution; 55-58
Lee Boltin.

Smithsonian is published monthly by
the Smithsonian Associates,
900 Jefferson Drive, Washington, D.C. 20560.
© Smithsonian Institution 1970. All rights reserved.
Reproduction in whole or in part without permission is
prohibited. Subscription price $10 a year in U.S.
and possessions, $11.50 elsewhere.
Second class postage paid at Washington, D.C.
Editorial offices at Arts and Industries Building,
900 Jefferson Drive, Washington, D.C. 20560.
Advertising and circulation offices
at 420 Lexington Ave., New York, New York 10017.
Please address all subscription correspondence
and change of address information
to P.O. Box 404, Flushing, New York, 11378.

Table of Contents

Cover: Figurehead and pegbox of a 1718 *viola da gamba,*
one of many antique musical instruments at the
Smithsonian in playing condition
Photograph by Lee Boltin (See page 52)

2 Letters to the Editor

4 In the world of energy and thermodynamics
you can't even break even
By Isaac Asimov

12 Dr. Ruth Patrick, a gracious prophetess of the fight
against pollution
By Michael J. Bandler

16 Riding history's path on a bicycle built for two
in an area which probably will be a national park
By Dorothy H. Geary, photographs by
Colonel John M. Geary

24 Are detergents, the work-savers, helping
to ruin our waters?
By Kenneth M. Reese, drawings by Dill Cole

32 Animals and Man in East Africa learn to get along
Article and photographs by Henry B. Weaver

36 A great new display of pre-Columbian art
By Bennett Schiff

42 My dandelions and yours—a salute to a stubborn
and much-maligned plant
By William J. Breisky

49 The fine art and sport of boomeranging

52 The Smithsonian's old musical instruments, dating
from the 16th century on, are really used
By Robert Evett
Color photographs by Lee Boltin

60 Book reviews

62 August events at the Smithsonian

64 The view from the castle: Secretary Ripley's comments
on Smithsonian's Tropical Research Institute

17 reasons why you should read psychology today

1. Why words are the least important of the ways we communicate with each other.
2. The sexual reason behind the popularity of natural childbirth.
3. Why political leaders are constantly in danger of insanity.
4. Why Asians make better politicians than Westerners.
5. Do men need more recreation than women?
6. What kind of parents do hippies make?
7. Why it may be time to end the taboo against incest.
8. The inferiority feelings of men who seek corporate power.
9. What the schizophrenic is trying to tell us.
10. Are campus activists rebelling against the system—or their parents?
11. What your daydreams reveal about your ethnic background.
12. Why do swingers tend to become impotent?
13. Is it time to grant the right to commit suicide?
14. Does a child think before he can talk?
15. Why are today's students attracted to violence?
16. Are "hawks" sexually repressed?
17. Are some men born criminals?

Want to learn what modern psychology has learned about people? Including you?

Until recently, that was quite an order. Your choice would have been to plow through professional journals. Read weighty new books as quickly as they came out. Or trust the mass media—where psychology is often sensationalized, distorted, oversimplified.

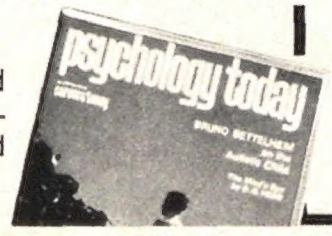
PSYCHOLOGY TODAY has changed all that. It allows the educated layman to catch up with the social sciences. And keep up. With full coverage of all the different approaches to understanding the human condition. The viewpoints range from hard-core Freudianism to the newer behaviorists who, frankly, think Freud was all wet.

It's psychology the way you'd want it to be presented. Excitingly. Without tired jargon. No cliche-ridden definitions. And with contributions by many of the most famous names in the behavioral sciences—like Bruno Bettelheim, Kenneth B. Clark, Rollo May, Ashley Montagu, Carl Rogers and B. F. Skinner.

Send for a complimentary issue

You can find out what PSYCHOLOGY TODAY is like—and learn a few things you may never have known before—without paying a penny. If you mail the coupon, we'll send you a complimentary issue of PSYCHOLOGY TODAY.

There's no obligation.



6-329

psychology today

P.O. Box 2990, Boulder, Colorado 80302

Please send me my complimentary current issue of PSYCHOLOGY TODAY. I may keep my sample copy and owe nothing. However, unless I cancel, you may enroll me as a trial subscriber and send me the next 11 issues. Bill me after my subscription has started for just $6.00, my special Introductory rate—instead of the regular $10 annual price.

Name_____
(Please Print)

Address_____

City_____

State_____ Zip_____

Letters to the Editor

Crab Nebula

Dear Sir: Stephen Maran's article on the Crab Nebula mystery was most informative. May we expect more on astronomy in future issues?

L. C. WALLACE

Memphis, Tennessee

Yes. Ed.

Dear Sir: Mr. Maran's article on the Crab Nebula is the finest piece of writing in the field of physical science I can remember.

HARRY FISH

San Francisco, California

Dear Sir: The June article about the Crab Nebula Mystery completely fascinates me.

Since the Crab is so far from the earth and at the time of the implosion (1054) there was not the sophisticated equipment for probing the galaxy that we have today, is it possible that the Crab had been a planet? Could it be a preview of what will happen to the planet earth if we don't heed ecological warnings?

It has been established that the earth is composed of different types of matter with people living on the crust. Parts of the foundation of the crust are layers of minerals: water, oil, gases. We are removing these foundations rapidly, and at the same time we are piling tons upon tons of additional weight (in the forms of cans, cars, bottles, fibers, etc.) on the crust that the diminishing foundations support. Is it possible, then, that these tons of man-made junk piling up all over the earth could be the makings of the compressor that, coupled with removal of the foundation layers, will ultimately cause the implosion of our planet? Could these two effects be more important than the extinction of certain insects and mammals in the ecological balance? (Evolution has been a series of extinctions, but, being organic matter, the products did not remain on the surface of the earth as do cans and bottles.)

MRS. P. L. MCNAIR

San Diego, California

Astronomer Maran tells us the Crab pulsar must have been a star, not a planet, before it collapsed. In Red Giants and White Dwarfs *Robert Jastrow writes that life on earth will end about five billion years from now when the sun becomes a red giant 100 times as big across as it is now. Joseph P. Riva jr., chief of Earth Sciences in the Smithsonian Science Information Exchange, believes no great collapse of the earth is possible though removal of coal, oil and minerals sometimes causes local settling of several feet.* Ed.

Earth Day

Dear Sir: In the June SMITHSONIAN I was amazed to see students giving the so-called peace sign. This, along with the communist salute . . . and the use of certain obscene words have become . . . symbolic of intolerance, hate, violence. . . .

THADDEUS T. MUDD

Richmond, Virginia

Mr. Mudd has unjustly accused the users of the peace sign of guilt by association with some students. Our reporters in nine places state that the sign meant what SMITHSONIAN *said it did—peace. They reported no obscenity, no violence on Earth Day.* Ed.

Japanese bamboo

Dear Sir: Data on the rate of growth of bamboo seems to present varying statistics. Alexander High Lawson in his book *Bamboos* states: "The bamboo of the tropics grows faster than any other living plant. . . . In India, a tropical species, *Bambusa tulda,* is on record as having grown 1½ inches in one hour. In North Africa, *P. mitis,* a hardy species, is known to have achieved the phenomenal growth rate of 20 inches in the space of 24 hours."

Carl Mydans' article on bamboo in the May issue of SMITHSONIAN states: "They may grow as much as 16 inches in a day, and in their early sprouting stage have been known to . . . grow a yard or more in a night." A letter from New York Botanical Garden states: "Dr. Howard Irwin and one of his staff members concur that bamboo may grow three feet in 24 hours."

CHAPMAN GRANT

Escondido, California

The article dealt only with the madake *variety in Japan. Specialist Takeyoshi Suzuki and Smithsonian Research Associate F.A. McClure, both authorities on this species, assured us it has been known to grow a yard or more in a night.* Ed.

'The broadest scope'

Dear Sir: If I had wanted another scientific engineering journal in the house I would not have subscribed. You've given my family a magazine we can all read with the broadest scope of any we have ever seen.

MRS. THOMAS A. OLIVER

Cudahy, Wisconsin

View from the Castle

Dear Sir. In the June issue, I was struck by the picture accompanying "The view from the castle." The prominent citizens there shown in the gathering of February 1927 do not include Charles Gates Dawes, Vice President of the United States. Is there any particular reason you know of for his absence? Is it not true that he was the ranking member of the Regents of the Institution? Is it not also true that Number 6 (Senator Smoot) was a vice-presidential appointee to the Board?

IRVING G. WILLIAMS

Director
St. John's University
Jamaica, New York

The minutes of the 1927 meeting give no indication of why Dawes is not pictured.

Dawes was a member of the Regents by virtue of his office but the chancellor, as the ranking member of the Regents is called, was Chief Justice William Howard Taft. Traditionally, the chief justice is chancellor although any member of the Regents may be elected. Senator Smoot was appointed to the Regents on December 2, 1924 by president pro tempore of the senate Albert B. Cummins. Ed.

Coral reefs

Dear Sir: I was pleased with the June article on coral reefs; the photography was excellent. But I believe an error was made in the text when the rock moray was ascribed to the genus *Echidna*. I think *Echidna* is the spiny anteater of Australia, and the rock moray pictured is of the genus *Muraena*.

TERRY W. SCHULZ
California State College
Fullerton, California

The family name of the spiny anteater was Echidnidae until 1872 when it was changed to Tachyglossidae. "Echidna" is still used as its common name as a throwback to the previous family name. The family name of the moray eel is Muraenidae. The genus of eel shown in the article is Echidna. *It is easy to confuse the two taxonomically, although certainly not physically.* Ed.

Visit the Smithsonian

Dear Sir: We Washington area residents, who never get a chance to visit your Institution but who drop off out-of-towners on our way to work, are now convinced. The arrival of SMITHSONIAN undoubtedly signals a new era of public respect for your growing, up-to-date and impressively aware Institution. We who spend our vacations elsewhere are deeply indebted to SMITHSONIAN.

T. DUKE FANCHER
Woodbridge, Virginia

More photos, less text?

Dear Sir: A word of caution: Keep it short! Do not yield to more and more pages as you grow and grow. Invest instead in more of those superb photos.

JOSEPH W. LUCAS
Cocoa Beach, Florida

The First to Fly

Dear Sir: You did not identify the shirt-sleeved pilot of Langley's "aerodrome before its unsuccessful flight in 1903." He was Charles Matthew Manly, who not

only helped to construct the plane but helped to build the engine, in addition to being the test pilot on October 7, 1903. He was such a good engineer that there has been a Manly Medal for some years awarded annually by the Society of Automotive Engineers.

WALTER C. HADLEY
Jamestown, Rhode Island

Libyan water

Dear Sir: The most significant article in the June issue was that treating the discovery of water under the Sahara. This piece is signed on page 44 by one Mary H. Cadwalader. But her name does not appear in the Table of Contents

CURTIS C. DAVIS
Baltimore, Maryland

Miss Cadwalader did write the final draft but the information came from a number of sources. Ed.

Dear Sir: Regarding the article on Libya's new-found water—I could not help but wonder about the problems Occidental Petroleum is probably also bringing to Libya in the form of nitrate and pesticide pollution of that "clean, sweet" water.

BARBARA JEPSON
Los Angeles, California

In the harsh, blistering-hot Libyan desert, the pollution threat is almost zero. The liquid fertilizers sprayed on the plants penetrate the sand only to a depth of 30 inches, eliminating almost any chance of nutrients reaching the water table which is 16 feet below the surface. The farming area is 500 miles from the coast, in an almost sterile environment, and the few insects there were probably brought in with the imported seeds. Some insecticides are used but in far less concentrated amounts than is usual in the U.S. Ed.

A college senior speaks

Dear Sir: I, as a college senior, congratulate you on your April, May and June issues of SMITHSONIAN. They are informative, interesting, readable.

MARY E. NARROW
Jackson, Mississippi

Comments on letters

Dear Sir: The insulting letter of Mr. Thomas F. Koester jr. is just one more of many reasons why more articles on black studies should appear.

DANIEL KLEIN
Flushing, New York

Dear Sir: You say in your May letters column "there is no evidence that liquor per se is harmful, only the overuse of it." How do you reconcile this statement with the findings of Dr. Melvin H. Knisely and associates at the Medical University of South Carolina? They claim that even a moderate drinker may lose some brain cells with every cocktail he drinks. Even though they estimate the average adult brain contains more than 17 billion cells, the cells that die are irreplaceable because the human body is unable to create new ones.

MRS. JAMES F. HERBERT
Haverford, Pennsylvania

We may have oversimplified, but other studies in the field do not substantiate the findings of Dr. Knisely. Some authorities, including researchers at the National Institutes of Health, say that there is no scientific evidence that alcohol in small amounts has any adverse effect on healthy people. In fact, many physicians still prescribe it for some of their older heart patients. Ed.

By Isaac Asimov

In the game of energy and thermodynamics you can't even break even

Two great laws describe flow and change of the universal prime mover; it is never created and never disappears

What a pleasure it is to be young, and hopeful, and unsophisticated. All things are possible, and we are ready, in our heart of hearts, to believe that a fairy godmother may just come and wave her wand and turn our rags into a lavish costume and our hovel into a mansion. Why shouldn't an enchanted ring exist somewhere that will, at a rub, load our pockets with gold and jewels? Or why should not a jinn, slave to our commands, build a castle for us in the twinkling of an eye and fill it with dancing girls?

If this has not happened, we might wistfully imagine that it is only because we just haven't been lucky enough to find the fairy godmother, or the enchanted ring, or the jinn. All we need is that incredible stroke of luck, and we will have something for nothing.

But never mind fairies, rings and jinns; in the real world it is energy that is the prime mover of all. We can define energy as anything that makes it possible to do work, anything capable of bringing about movement against resistance. In that case, we see at once that there must be various forms of energy.

Heat will make a thread of mercury rise against the pull of gravity; light will turn the vanes of a radiometer against the slowing effect of friction. Electricity will turn a motor, magnetism raise a pin, a moving bat hurl a baseball over the fence, exploding dynamite lift

Chemist, professor, writer—Dr. Asimov kindly helps you understand the Second Law of Thermodynamics. His article, in May, dealt with science fiction.

a boulder, a hydrogen bomb in action heave a huge mountain.

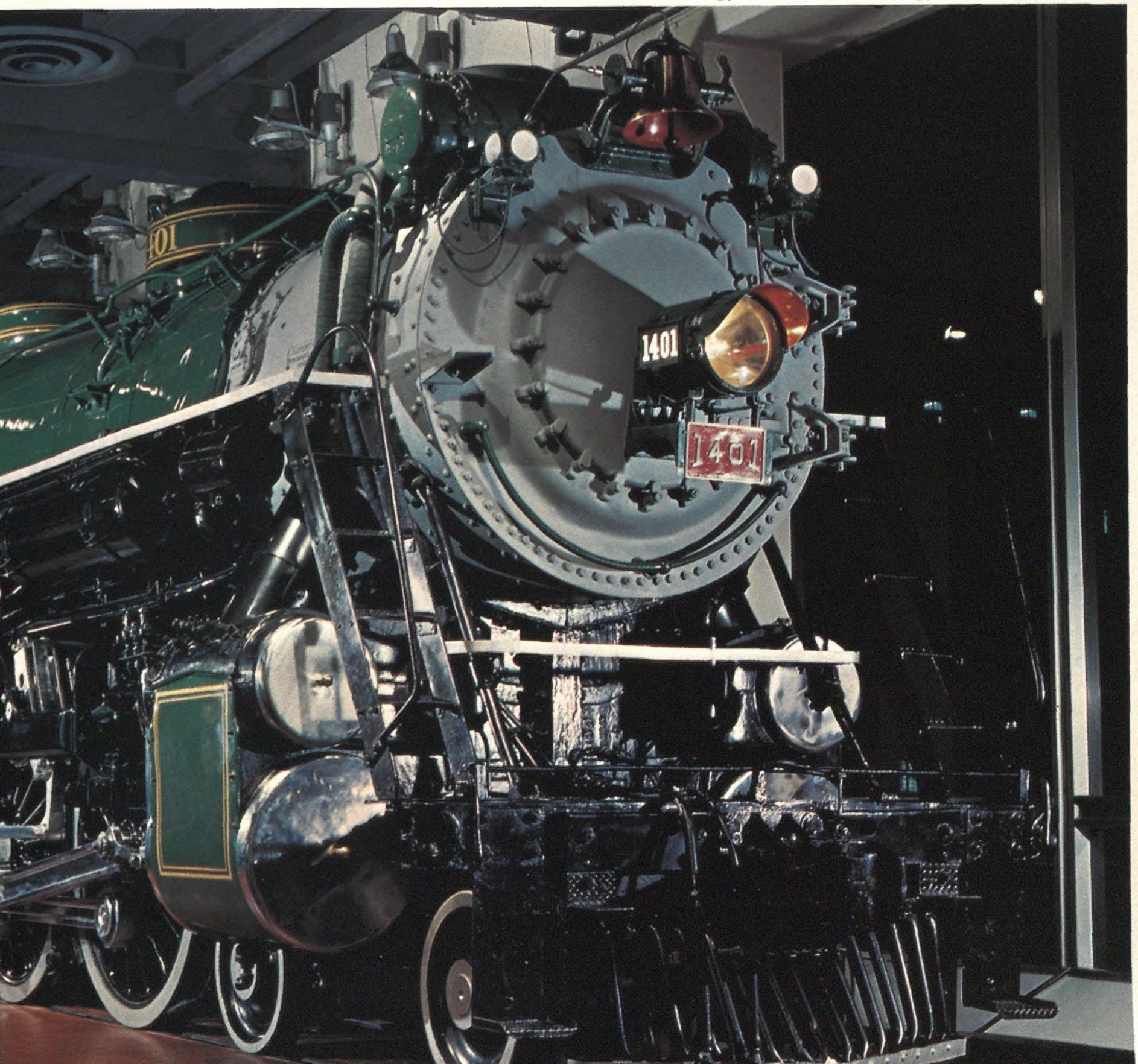
Heat, light, electricity, magnetism, motion, sound, chemical bonds, nuclear forces—all represent forms of energy, and all are different forms of essentially the same thing, for one form can be freely turned into another. Electricity moving through a wire can produce light, and a paddle rotating rapidly in water can produce heat. Magnetism can be turned into electricity, chemical explosions into motion, nuclear reactions into sound, and so on.

We have now sharpened the problem of getting something for nothing and can consider it realistically. Whatever we want costs us energy, for it is only energy (by definition) that will allow work to be done. To be sure, we may need other things as well. To build a palace we need not only the energy to lift materials but also a certain architectural knowledge—but we need energy *at the very least*. Without energy, all the architectural knowledge in the world wouldn't budge one grain of sand.

To get something for nothing, then, is just another way of saying this: We want to create some energy that did not exist before.

But, alas, this apparently can't be done. In the 1840s, as a result of careful experimentation and mea-

This Pacific-type locomotive, on display at the Smithsonian Museum of History and Technology, converted the energy of heat to work.



surement, several physicists came more or less simultaneously to the conclusion that energy cannot be created. One form of energy can be converted into another, or transported from one place to another, but that is as far as we can go.

But wait, that isn't all. If energy cannot be created, neither can it be destroyed. When energy is used, it doesn't disappear; it merely goes elsewhere or is changed into another form. The light that streams out of a candle does not vanish; it heats up the air and surroundings about itself. The hot water in a kettle may cool down but the heat does not disappear; it is transferred to the outside world.

To express all this, we can say: "Energy can be transferred from one place to another, or transformed from one form to another, but it can be neither created nor destroyed." Or we can put it another way: "The total quantity of energy in the universe is constant."

When the total quantity of something does not change, we say that it is conserved. The two statements given above, then, are two ways of expressing "the law of conservation of energy." This law is considered the most powerful and most fundamental generalization about the universe that scientists have ever been able to make.

No one knows *why* energy is conserved, and no one can be completely sure it is truly conserved everywhere in the universe and under all conditions. All that anyone can say is that in over a century and a quarter of careful measurement, scientists have never been able to point to a definite violation of energy conservation, either in the familiar everyday surroundings about us, or in the heavens above or in the atoms within.

Conservation is the starting point

The study of changes of energy from one form to another and the transport of energy from one place to another is called "thermodynamics" (from Greek words meaning "heat motion"), because the earliest studies of the sort were made on the manner in which heat flowed from one part of a system to another.

For that reason the law of conservation of energy is sometimes called the First Law of Thermodynamics. It is first because it is the starting point for all else in the study. Before you can come to any useful conclusions in thermodynamics, you must accept the fact that energy can be neither created nor destroyed.

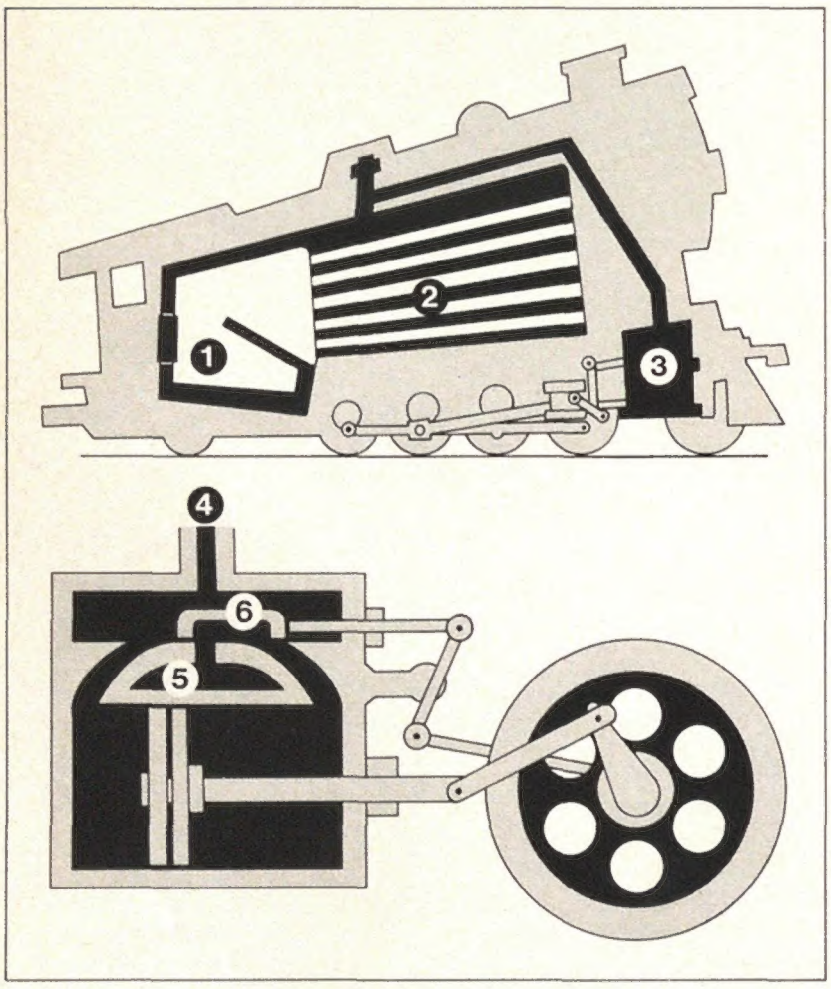
Once that is accepted, we might decide that even so we have not entirely lost. In the great game of the universe maybe we can still win. If we can't get something for nothing, maybe the First Law will allow us to get something for *almost* nothing.

For instance, heat is a form of energy, and we can make it do work. Moreover it is all around us—in the earth under our feet, in the air, in lakes and oceans and winter snows. Suppose we take a quantity of heat and change it into work. In doing so, we haven't destroyed the heat, we have only transferred it to another place or perhaps changed it into another energy form. Why can't we then simply gather it up, wherever it is and in whatever form, and use it again and again and again?

If we can do so, then even if we can't create energy out of nothing we can at least start with just a little energy and make it do any amount of work. By using the energy of a burning candle over and over we could move the world; and it would be a greedy man indeed who wouldn't be satisfied, or who would complain he wasn't really getting something for nothing.

Alas, it sounds good, but it can't be done. The trouble is that once energy is used, it still exists, but it is spread out thinner. The heat of the burning candle spreads out into the air all about and into all the things the warm air comes into contact with.

For that heat to work again, it has to be collected



Heat in the locomotive firebox (1) makes steam in the boiler (2), which flows to the cylinders (3). Entering the cylinders (4) steam pushes the piston from the left while spent steam flows out through exhaust channel (5). Then slide valve (6) moves to interchange intake and exhaust for return stroke.

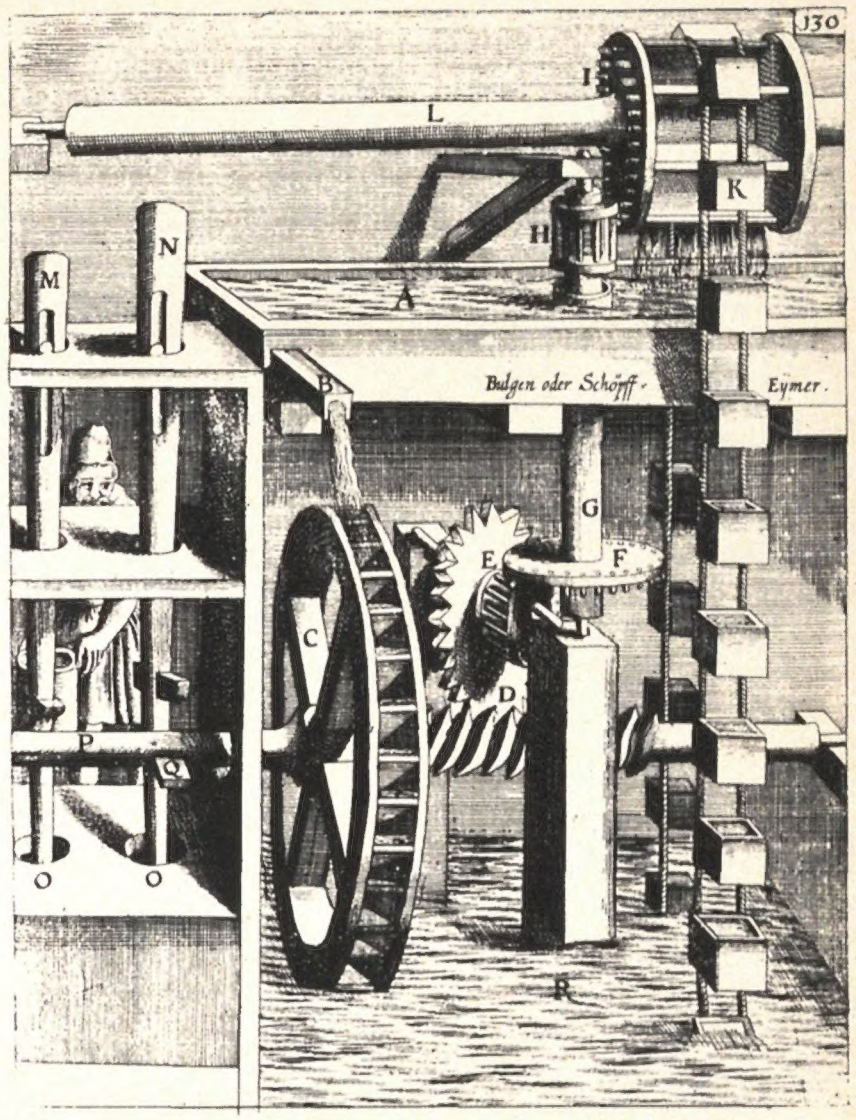
from the surroundings and concentrated again so that the candle flame is re-created. Heat *can* be concentrated, energy *can* be collected—but it takes energy to do so, invariably more energy than the energy you are concentrating and collecting.

(Think of your air conditioner. It collects heat from a cool room and discharges it, at higher temperature, into the outside air. Why not use just such a heat pump to concentrate heat where we want it? Then we could let the heat flow once again from a hot place to a cold place, making it turn motors, lift weights and generate electric currents as it went. We've found a jinn after all! But there is a joker in the deck that overrides the jinn. More energy is needed to run the air conditioner than we can get back by letting the heat run back from hot to cold.)

What is the sense in using fresh energy to collect dissipated old energy, and using more to get less? You might as well use the fresh to begin with. It is more economical. In short, in your attempt to use the same old energy over and over again, you would be using up more energy than if you made up your mind to use each bit of energy just once.

You can't get around it. What the laws of thermodynamics really say is that in the great game of the universe, *you can't win!* You can't get something for nothing, or even for nearly nothing.

(Through centuries inventors have been trying to beat this game and invent perpetual-motion machines. With rolling balls and swinging weights and spinning wheels they have tried repeatedly to make a machine that would run on, once started, getting just a little energy from gravity or some other source to overcome the little bit of friction in its bearings. Such a machine, if you could make it, would be a perpetual-motion machine of the kind that would violate the laws of thermodynamics. Nobody has succeeded; nobody ever will; very few, if any, are still trying.)



Before men understood conservation of energy, they tried, with machines like this one, to get something for nothing: perpetual motion.

All work and no waste are impossible

This impossibility is a hard thing to accept, and the indomitable human spirit is bound to fall back to the next line of defense. If it is true that you can't win, then perhaps you can at least break even. In other words, given a certain supply of energy, perhaps you can at least turn it *all* into work.

This problem came up when the steam engine was first developed in the 18th century. To begin with, the early engines were *extremely* inefficient. Great quantities of fuel were burned, but most of the energy was wasted in heating up the world generally; very little ended in such useful work as pumping water.

Naturally, one assumes that if one could only cut down on friction, prevent the flow of heat in unwanted directions, make the general design more efficient, one could eventually build a machine that would turn *all* the energy into work.

The first person to point out that this was not so, that even a *perfect* steam engine could not turn all energy to work, was a French physicist, Sadi Carnot.

He demonstrated in 1824 that the steam engine did work because part of its system was quite hot (the part that consisted of steam) and part was quite cold (the part that consisted of the cold water that condensed the steam). The heat energy present was, in other words, in greater-than-average concentration in one place and less-than-average concentration in another. The engine worked by taking some heat from the hot part, transforming some of it into work, and dumping some of the heat into the cold part. Unfortunately you always had to dump some heat into the cold part; you couldn't transform all the heat you extracted into useful work. The fraction of energy that could be turned into work by a steam engine depended upon the difference in heat concentration (that is, "temperature") between the hot part of the system and the cold part.

The greater the difference in temperature between two parts of the same system, the greater the fraction

of the heat energy we can turn into work. This difference in temperature becomes a maximum when *all* the heat in the system is concentrated in one part and *none* is concentrated in another.

The trouble is that physicists have shown it is impossible to concentrate *all* the heat in a system in one particular part of it. Even to approach total concentration takes an enormous effort.

If a steam engine uses ordinary steam for its hot part and ice water for its cold, the difference in temperature is such that only 27 percent of the total heat energy could be converted into work, even if the steam engine were perfect in every other respect, if it lost no heat to the outside, if there were no friction, and so on.

Like water, energy flows downhill

This is true of any system that uses energy of any kind. To make any system useful, to allow it to turn energy into work, there must always be a difference in energy concentration in different parts of the system. There must be a high-energy concentration here and a low-energy concentration there, and the work to be got out of the system depends not on the total energy, but on the difference in energy concentration within the system.

We can say: "No device can deliver work unless there is a difference in energy concentration within the system, no matter how much total energy is used."

That is one way of stating what is called the Second Law of Thermodynamics. It is one of many ways; all of them are equivalent although some very sophisticated mathematics and physics is involved in showing the equivalence.

Since there is never any way of reaching an ultimate difference in energy concentration, never any way of putting *all* the energy into one part of the system and *none* into another, we can never turn every bit of the energy of a system into work. Some of the energy always manages to get away from us without being turned into work.

What the Second Law tells us, then, is that in the great game of the universe, we not only cannot win; *we cannot even break even!*

Given energy at two different levels of concentration, we will note as part of the common experience of mankind that there is always a spontaneous transfer of energy from the place of higher concentration to the place of lower concentration and never vice versa. For instance, heat will flow, of itself, from a hot body into a cold body, but not vice versa. Water will flow spontaneously downhill, but not vice versa.

Physicists can show that this principle explains why devices will convert energy into work when there is a difference in energy concentration within the system. Spontaneous energy flow from high to low produces the work.

The statement about spontaneous energy flow is therefore another way of expressing the Second Law. It is equivalent to our earlier expression (the impossibility of converting all of any amount of energy into work) in the following sense: The energy that cannot be converted must be dumped into a cold place, and hence we have a flow of this energy from hot to cold.

But work is never done instantaneously. It invariably occupies time. What happens during that time?

Suppose we consider a steam engine with a portion of itself that is at high-heat concentration and another portion that is at low-heat concentration. By the Second Law, the heat flows from high to low and in the process some of the heat is turned into work. If the heat flow happened all at once and was converted into work in zero time, then we would at least get all the work out of the energy flow that we could. But it takes time, and as time passes, some of the heat in the high-concentration portion is pouring out into other parts of the universe. Meanwhile, heat from other parts of the universe is pouring into the low-concentration portion. In other words, the hot part of the steam engine is cooling faster than you would expect just from its transfer of heat to the cold portion. The cold portion, on the other hand, is warming faster than you would think just from its receipt of heat from the hot portion.

The *difference* in temperature is dropping faster than you would expect from the work done.

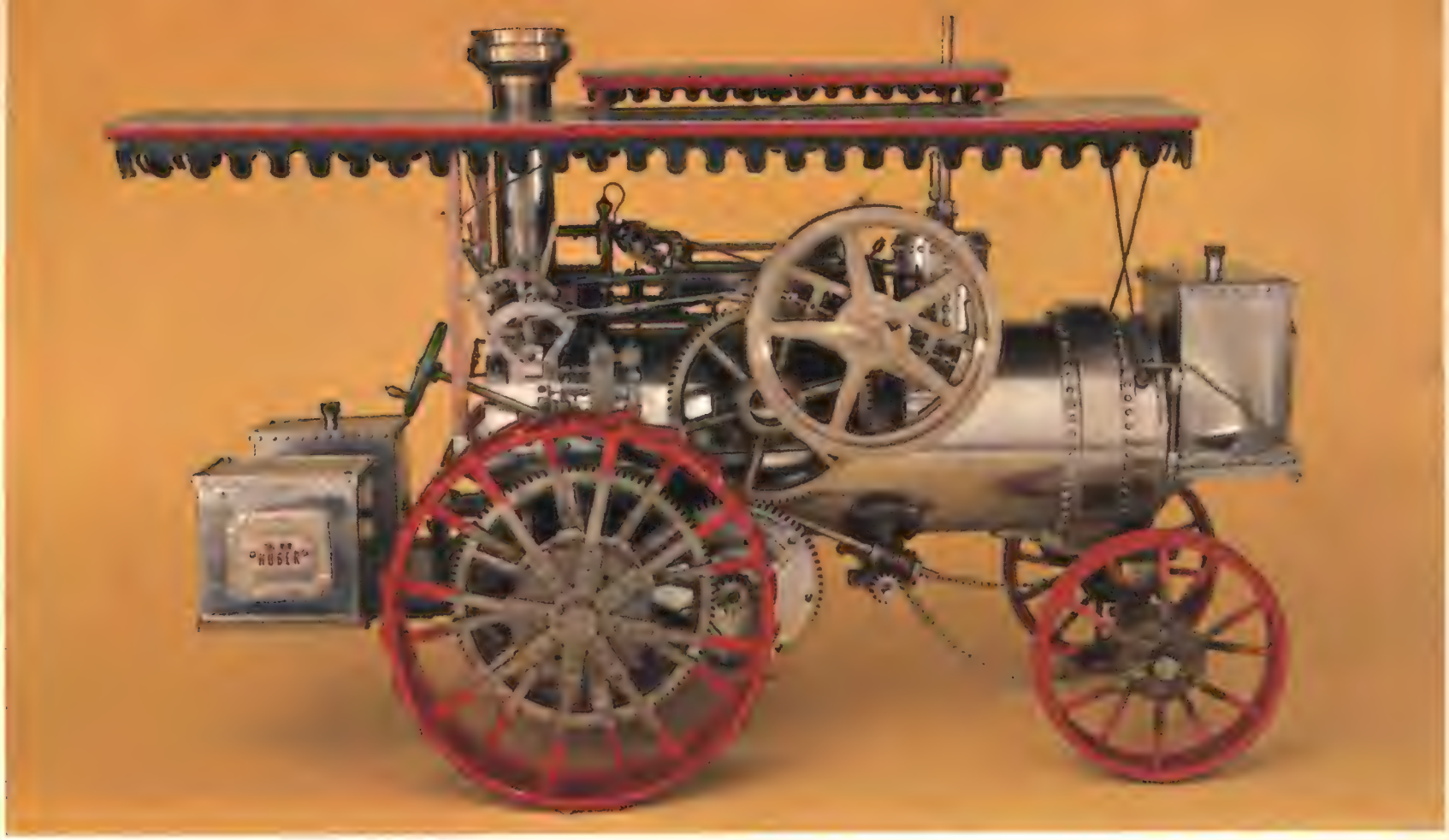
A German physicist, Rudolf Clausius, pointed out this fact in 1865. He invented a quantity consisting of the change in heat divided by temperature, and called it "entropy." He showed that entropy was a measure of the quantity of energy *not* capable of conversion into work.

Energy available is always getting less

In any physical change that takes place by itself the entropy always increases. In the case of the steam engine it is because there is heat flow to and from the universe. If a boulder rolls down the mountainside, there is increase of entropy because of friction and air resistance. An electric current flowing from one pole of a battery to another encounters resistance from whatever it passes through and hence experiences increase in entropy.

To be sure, we can imagine ideal cases. A rock might fall through a perfect vacuum; an electric current might flow through a perfect conductor. In these cases, there is no entropy increase.

But approximations to such ideals—a planet moving through outer space, an electric current moving



Despite its shine and elegance, this steam tractor, now the Smithsonian's, was limited by heat it dumped and lost—in other words, by the Second Law.

through a superconducting metal—are highly special. If we consider the ordinary systems we work with, we can say: "In any energy transfer, there is an increase in entropy."

This, too, is a way of expressing the Second Law. In fact, a good brief way of stating the First and Second Laws of Thermodynamics is: "The total energy content of the universe is constant, and the total entropy is continually increasing." This means that although the universe never loses any energy, less and less of that energy can be converted into work as time goes on.

The Second Law can be interpreted in terms of atomic theory, and the Scottish mathematician James Clerk Maxwell did so in the 1860s.

Heat can be viewed, for instance, as being represented by the random movements of the separate particles (either atoms or molecules) making up some body of matter. The greater the *average* velocity of particle motion, the higher the temperature.

When two particles collide, they bounce apart and some momentum (mass multiplied by velocity) is transferred from one to the other. The transfer can take place in any fashion, but the most likely result is that the particle with greater momentum will lose some, and the particle with less momentum will gain. In short, if all the particles are the same size, the faster particle will slow down after collision and the slower particle speed up. It is possible, of course, that a fast particle may just happen to bounce off faster, and the slow one slower, but it is unlikely.

Let us suppose there is a one-in-ten chance that a fast particle will bounce off a slow particle and become faster in the process. The chance of six fast particles *all* bouncing off faster from six slow particles will be one in ten times ten times ten times ten times ten times ten, or one in a million. The chance of 96 fast particles all bouncing off faster at the same time from 96 slow particles would be only one in a trillion-trillion-trillion-trillion-trillion-trillion-trillion-trillion.

Suppose you took a kettle of water containing uncounted trillions of particles and put it over a fire. It might be that more than half of the hot, very-fast-moving particles in the hot gasses of the fire might strike the kettle and bounce off moving still faster. In that case, the water in the kettle would get cooler while the fire got hotter. The Second Law would be violated. From a philosophical viewpoint one can argue that this process is possible and that the Second Law is no law at all—just a tendency that is more likely to be followed than violated. But the chance of its happening is so small that there is no way of writing it in ordinary figures. If you tried to write: one chance in such-and-such a number, the surface of the earth wouldn't be large enough to hold all the zeros you would have to write.

That is why the entropy of the universe constantly increases—because the collisions of atoms and molecules tend always to chop off energy extremes. Wherever energy is more concentrated than usual, that concentration drops; where it is less concentrated than usual, that concentration rises.

It is also possible to think of entropy in terms of order and disorder. Something is orderly when its individual parts are arranged according to some simple

rule we can quickly grasp. We can then predict from each part something about the next part. The simpler the rule, the easier the prediction, and the greater the order. This statement originally applied to the order and disorder in physical systems, and it can be related to their heat and energy content. But with a little extension we can apply it to a lot of common everyday situations.

Disorder is so easy; order is so hard

Consider a deck of cards. You might have it arranged as follows: ace of spades, two of spades, three of spades and so on, followed by hearts, clubs and diamonds, each suit arranged from ace to king. That is very orderly; for if you show me any card (the seven of clubs, for instance), I will instantly tell you the next card (the eight of clubs). Even if you put the four suits together differently, or arrange each suit in a sequence that runs from king down to ace, they still represent order.

We might also arrange the cards so that they are alternately red and black, but without any consideration for numbers or suits. If I am shown the seven of clubs, I can predict that the next card will be a red card, but that is all. Red-and-black-in-alternation still represents some order, then, but not much.

It should be obvious, though, that if you consider all the possible arrangements of the 52 cards in a deck, the number of arrangements that allow you to make predictions about a card from the preceding one is a small, a *very* small, portion of the whole.

Suppose you shuffle a deck in such a way that it can fall into *any* arrangement. The chances that the arrangement will be one of the few that will allow even a small amount of prediction, and will therefore have at least a small amount of order, are not great.

That is why, when you shuffle cards thoroughly, you would be most astonished to find, when you are through, that the cards have ended up with each suit in perfect sequence—ace of spades, two of spades, and so on—or even red-black-red-black all the way to the end. Let us take another example. When a platoon of soldiers marches past four abreast and in perfect step, that represents a high degree of order. When we see one rank of four soldiers move by, we can predict exactly when the next rank will pass by, how many will be in it, whether they will be moving their right feet or left at the moment of passing, and so on. Other examples of order would have soldiers moving two abreast or in single file or one rank marching and the next skipping, in alternation.

But suppose you considered all the different possible ways in which the individual soldiers of a platoon could pass by if each consulted his own tastes only and paid no attention to the others. Some might be strolling, some walking, some running, some hopping perhaps, some in this direction, some in that. The number of ways of passing *without* any perceptible order is much higher than the number of ways *with* order.

Consequently, if you told the soldiers of a platoon to move from one point to another at will, you would be utterly surprised if, when each did exactly as he pleased, they just all happened to move four abreast and in step. In fact, if they were already moving four abreast and in step and were suddenly told to do as they pleased, you would expect the entire platoon to break formation and become disorderly. In short, in every possible situation you can think of, the number of ways of being disorderly is much, much greater than the number of ways of being orderly.

This is exactly comparable to the fact that the number of ways in which extremes get chopped off in the random collisions of particles is much, much greater than the number of ways in which extremes get more extreme.

Another way of stating the Second Law, then, is: "The universe is constantly getting more disorderly."

Viewed that way, we can see the Second Law all about us. We have to work hard to straighten a room, but left to itself, it becomes a mess again very quickly and very easily. Even if we never enter it, it becomes dusty and musty. How difficult to maintain houses, and machinery, and our own bodies in perfect working order; how easy to let them deteriorate. In fact, all we have to do is nothing, and everything deteriorates, collapses, breaks down, wears out, all by itself—and that is what the Second Law is all about.

Maybe life is the great exception

You can argue, of course, that the phenomenon of life may be an exception. Life on earth has steadily grown more complex, more versatile, more elaborate, more orderly, over the billions of years of the planet's existence. From no life at all, living molecules were developed, then living cells, then living conglomerates of cells, worms, vertebrates, mammals, finally Man. And in Man is a three-pound brain which, as far as we know, is the most complex and orderly arrangement of matter in the universe. How could the human brain develop out of the primeval slime? How could that vast increase in order (and therefore that vast decrease in entropy) have taken place?

The answer is it could *not* have taken place without a tremendous source of energy constantly bathing the earth, for it is on that energy that life subsists. Remove the sun, and the human brain would not have developed—or the primeval slime, either. And in the billions of years that it took for the human brain to

develop, the increase in entropy that took place in the sun was far greater; far, *far* greater than the decrease that is represented by the evolution required to develop the human brain.

But where did it all start? If the universe is running down into utter disorder, what made it orderly to begin with? Where did the order come from that it is steadily losing? What set up the extremes that are steadily being chipped away?

Scientists are still arguing the point. Some think the universe originally had its matter and energy all smashed together into one huge "cosmic egg"—a situation something like a tremendous deck of cards all arranged in order. The cosmic egg exploded, and ever since, for billions of years, the universe has been running down; the deck of cards is being shuffled and shuffled and shuffled.

Others think that there is some process in the universe that spontaneously decreases entropy, some natural process that unshuffles and reorders the cards. We don't know what it can be, perhaps because it takes place under conditions we cannot observe and cannot duplicate in the laboratory—say in the center of exploding galaxies. Perhaps, in that case, as some parts of the universe run down, others build up.

Then again, it may be that once the universe runs down, the random collisions of particles may—after some unimaginable span of years—just happen to bring about an at-least-partial unshuffling. After all, if you shuffle and reshuffle cards ceaselessly for a trillion years, you may violate the Second Law and end up with an arrangement possessing at least *some* order, just by the laws of chance.

Once that happens, the universe begins to run down again at once. Perhaps, then, we live in a universe that was partially restored to order after a quadrillion years of having been run down. We are now running down again. After the universe is completely run down, another quadrillion years or so may see a section of it unshuffled once more.

Stars and galaxies will then form again, and life may be established here and there, and finally some science writer will sit down and begin to wonder again where it all came from and where it all will end.

Water pumps water in this machine, now on display at the Smithsonian. Fast jet at bottom turns the wheel, which drives the pump at right.

By Michael J. Bandler

Dr. Ruth Patrick, a diagnostician of water pollution

This famed limnologist parlayed girlhood fascination with the world of nature into her continuing fight for its salvation

When Dr. Ruth Patrick was growing up in Kansas City, Missouri, more than a half-century ago, her biggest treat was "to go into my father's library, climb up on his knee and look through his microscope. This was the reward for being a so-called good girl."

These token rewards have reaped immeasurable benefits for us all, whether or not we are aware of them. Today, Ruth Patrick—much-honored limnologist, diatom systematist and environmentalist—continues to pursue her father's first love, biology, and to follow his chief tenet: One must leave the world a little better for having lived in it.

Sparrows, robins, blue jays and pheasant inhabit the dense woodland surrounding the glade in Chestnut Hill, Pennsylvania, where she lives with her husband, Dr. Charles Hodge. Their rambling ten-room house has a sloped garden in the front and a greenhouse in the rear. From here, Dr. Patrick commutes daily to her office at the 158-year-old Academy of Natural Sciences in downtown Philadelphia, 35 minutes away. She is chairman of the Academy's 70-man department of limnology.

"I am Ruth Patrick professionally to avoid confusion in research," she says. "I'm Mrs. Charles Hodge in my home."

Michael J. Bandler is a Washington freelance writer who specializes in stories relating to environmental affairs. A group of eight of his reviews appeared in the June SMITHSONIAN.

Colleagues and friends know the scientist as an outspoken but gracious lady. The wilds of the Amazon and the murky waters of the Houston Ship Channel —"the worst, in terms of pollution, that I have ever studied"—seem unlikely locales for such a person, but she has visited and examined them, as well as some 700 other sections of rivers and waterways both at home and abroad.

The significance of Dr. Patrick's contributions to the scientific field was recently acknowledged by her peers when she was elected to the National Academy of Sciences—one of only nine living females out of 870 members and 12 ladies in the Academy's history. No wonder she calls it "the highlight of my year."

Dr. Patrick's interest in limnology—the studies of bodies of fresh water, with reference to their physical,

Dr. Patrick eyes some aquatic invertebrates at the Stroud Laboratory in Philadelphia.

geographical and biological features—harks back to her upbringing. Her father was an attorney by profession and a serious scientist by avocation. He had been thoroughly indoctrinated in biology at Cornell and would take Ruth and her sister on Sunday expeditions into the woods to investigate natural science.

Dr. Patrick now embarks upon expeditions as a limnologist and pollution consultant. She is also a master of diatom systematics—the classification of diatoms (unicellular plants coated with a wall of silicon) and their evolutionary relationships of species and families.

Her study adds greatly to our knowledge of water pollution. She was the first to diagnose the health of a stream by measuring the diversity of plant and animal species that grow in it. A healthy stream has a high diversity of species—which includes, of course, a large number within the diatom community. Any shift in the structure of that community is then a warning sign. Dr. Patrick has developed a system which shows by the type of shift, what kind of pollution is entering the stream.

Her scientific education trained her to be a theoretical biologist, involved with basic scientific theory. That always has been her key concern. However, one day in 1947 she delivered a talk on diatoms before the American Association for the Advancement of Science. A Philadelphian named W. B. Hart—a pioneer in the field of water pollution—heard her, and urged her to apply herself to solving society's problems.

A survey of pollution

It wasn't just talk, either. To enforce his suggestion, he raised $65,000 from Pennsylvania's Chamber of Commerce and donated it to the state, which in turn charged Dr. Patrick with the task of determining—from the structure of the aquatic communities—how pollution was affecting the state's rivers. She initiated her survey in the farmlands of the Conestoga Basin near Lancaster, on the fringes of the Amish country.

The Patrick project ascertained that one might measure the *degree* of pollution by the changes in the kinds of aquatic species and in the relative sizes of aquatic populations. By these changes, the two teams of scientists, each with a chemist, a bacteriologist, a phycologist, a protozoologist, an entomologist, an invertebrate zoologist and an ichthyologist, developed a scheme to plot the health of rivers.

"We were not after action then," she recalls, taking cognizance of ecological activism of today. "We were using the Conestoga as a place to study; whether or not we influenced industry or the state at that time I'm not very sure. But I am sure that later our findings often had an influence."

From the Conestoga, during the next 23 years, she moved on to the Savannah River, Texas' Guadalupe and Sabine rivers, the San Joaquin in California and then abroad—to Brazil, Ireland, Peru, New Zealand ("I paid for most of that one myself!"), Thailand and elsewhere, both to study pollution and the theoretical aspects of river communities.

Dr. Patrick firmly believes in "use without abuse," and feels that baselines must be established, so that an industry or a community can know whether or not it is polluting. "Unfortunately, today most of our streams have been more or less hurt by pollution. Of course, we are all polluters. Man really is the cause of pollution. It's his way of life."

Ruth Patrick agrees that "we must get people aroused, we must get them interested," and therefore a mild overstatement of the pollution problem may be

justified. But she maintains that the time has come to become involved in programs that "teach the facts. People make all sorts of statements about thermal pollution, and about eutrophication, and some of these are true and some are not."

Our wastes useless to nature

Industry, for example, must be educated. She cites Dr. Helmut E. Landsburg's view that during 40 percent of the nights on the eastern seaboard of the nation, there is an inversion in most areas. "So long as the wind blows the air away in the morning you don't have a pollution problem. But I think that industry ought to be aware that the conditions which make these very irritable smogs prevalent do exist. Therefore, patterns of industrial discharge, if they have to be made, should be aimed at minimizing the retention of these irritants in the atmosphere.

"We must learn how to eliminate waste, and also to reuse materials. The longer we allow things to hang around the more entropy there is in the system. We're the only organism whose waste does not become the food of some other organism. So we pile up these useless wastes. Moreover, we are extravagant in our use of certain very limited natural resources, for instance, phosphorus, cobalt, titanium and even aluminum. At the rate we're using them and not returning them into the cycle, we will be unable in the future to have as affluent a civilization as we have now. So industry should spend great sums of money on reuse of its products, as well as its waste materials."

The air around Viburnum Ridge—the Hodge residence—is clear and exhilarating; automobiles seldom ply their way down the nearby road adjacent to the two-acre property.

Over the fireplace of the book-lined living room is the portrait of a Hodge ancestor who married Benjamin Franklin's granddaughter. Two Franklin teacups are displayed at the entrance of the room.

Outside on the patio, beyond flowered drapes and myriad knickknacks, Charles Hodge often strolls with Blackie, an exuberant poodle. Dr. Hodge recently retired as a professor of entomology at Temple University. His wife of 39 years is proud of the silver bowl his students gave him when he left. "In this day, when most professors are so concerned with their research, I think Charles stood out as a professor who really cared about the education of his students."

A brown rug—with an unfamiliar pattern woven into it—lies on the floor in front of the fireplace. "That's what a diatom looks like," Dr. Patrick explains. Her son Charles who is a student at Davidson College in North Carolina hooked it for her.

As a student of aquatic life, Dr. Patrick is keenly aware of the benefits to be gained in the future from the culturing of marine foods. "If we're going to take care of our population, we must learn to shorten the energy transfer system. Algae-eating fish are one of the best ways to accomplish this end of efficiently transforming the initial producer-organisms into protein foods. And other countries are so far ahead of us in managing sea products that I think aquiculture is one of the great things that will develop."

Is there such a thing as a clean river, one from which people can drink? "Well, our water commissioner in Philadelphia says he can make most water fit to drink, and technically this is probably true," she says. "Most of our drinking water, wherever it comes from, is treated according to health laws. There are portions of small streams throughout the United States—even in places as urbanized as New Jersey—that may be safe to drink in their natural state. But large rivers that are untreated have relatively few safe sections.

Cooking, reading, swimming

Hobbies are virtually nonexistent for Dr. Patrick. In a sense, her work is also her hobby. She enjoys cooking, but feels she must have full-time help so her husband won't have to prepare his own meals when she is away. She loves to swim in the family's modest pool behind the house. She would like to read much more in the social, political and intellectual fields than she does, but hasn't the time. She has many friends, and enjoys music and art. "I intend to become much more of a scholar in terms of wide reading." For the time being, however, she contents herself with scholarly journals and books in her field—*The White Nile, The Blue Nile, The Population Bomb*—and a few magazines.

Involved as she is in the work before her, Dr. Patrick is attuned to the dissent flaring up at present, especially among her own sex. "Women, as any group of people, ought to have equal rights and equal pay for the work they do," she maintains. "And it amazes me

how many men will say—I have heard it in this city—'We couldn't possibly pay our women as much as we pay our men; it would break us.' And I think this is all wrong. I think women should have equal opportunity. On the other hand, I am not a feminist, in the sense that I believe that if you work hard and are intelligent, and conduct yourself in a manner suited to the occasion, you will get ahead. The worst thing is when women are young—and I remember it so well—and men don't believe they are serious. Many professors won't take women as graduate students because they say it's a waste of time. This is wrong."

Earth Day (SMITHSONIAN, June 1970) was a pleasant experience for her. The Academy of Natural Sciences rented a major auditorium in downtown Philadelphia so that "the ordinary secretary, stenographer and business person could attend, because the college students' Earth Day celebration was held out in Fairmount Park several miles from the business district, and the person who was employed couldn't get there."

Dr. Patrick delivered a principal address at the session during the noon hour. Later, she addressed the closing session of her Academy's symposium.

Although she has received acclaim throughout her career, the accolades, of late, have come with a rush—her election to the Academy, her first honorary degree.

She is a trustee of her alma mater, Coker College in South Carolina. Further degrees came from the University of Virginia. She has won the YWCA Centennial Award, the Gimbel Philadelphia Award, the Richard Hopper Day Award. Many times she has been selected to serve on national and international scientific panels.

She seizes the chance to discuss her future goal. "I believe that we are going to have to learn how to manage small amounts of pollution entering our waterways, much as we manage soils to produce the desired crops. In every stream, there are various kinds of algae—blue-green algae, green algae and diatoms. Diatoms are by far the preferred food source, and if somehow we can learn how to direct the nutrients so that they flow through diatoms instead of the blue-green or green algae, we will produce more fish instead of nuisance growths, thanks to the added nutrients. I hope to get a grant for experimentation to see if such a scheme is possible."

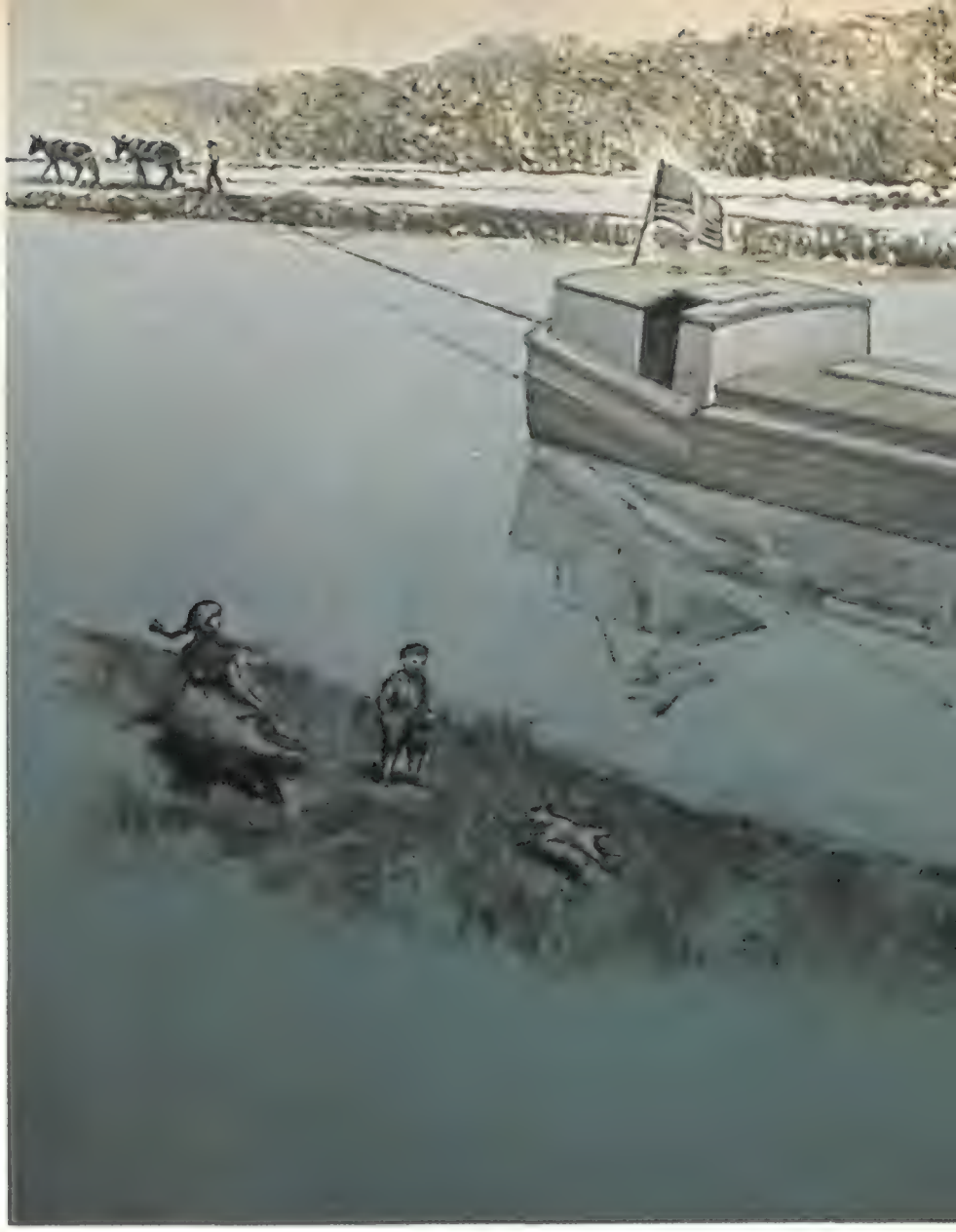
Will she ever start to take life easy? The answer is quick and succinct: "I shall never get out of my scientific research as long as I live."

With her colleague, Dr. Robin Vannote, Ruth Patrick studies some aquatic insects found on rocks. Laboratory is part of the Academy of Natural Sciences.

By Dorothy H. Geary

Riding history's path on a bicycle built for two

A backseat driver's view of a strong candidate to become a new national park: the Chesapeake and Ohio Canal



Mule-drawn canalboats slid along at between two and three m.p.h. If completed, the C&O Canal would have breached the Appalachian Mountains.

When Jack retired from the Air Force, we settled in Washington, D.C.—in time for our Silver Wedding Anniversary. My present was a tandem bicycle. We discovered that the towpath of the Old Chesapeake and Ohio Canal was an ideal place to ride it and we have logged over 200 miles in a year on weekends and holidays.

As the path worked its wiles on us, we rode farther and farther, until finally the lure of that corridor through the vaulted cathedral of trees was too much for us. We looked at each other one day and decided to ride the whole distance—184 miles from Cumberland, Maryland, to Georgetown, paralleling the Potomac River most of the way.

The Canal was started in 1828 to provide a transportation route that would connect tidewater Maryland and Virginia to Pittsburgh on the Ohio River, 360 miles away. As many as 6,000 laborers—some Irish, some German, many indentured—worked on the project, lured by a wage of ten dollars a month and a promise of meat and whiskey every day. The Canal never reached the Ohio but ended in Cumberland. It took 22 years and about $14 million to build it, but it provided leisurely transportation until floods and competition closed it in 1924. Now it is waterless for most of the distance but the long ribbon of dirt towpath still winds through the tunnel of trees.

For years, the lower portion of the Canal, from Seneca downstream to Rock Creek Park in the District of Columbia, has been part of the National Capital Parks system. President Eisenhower made the rest a National Monument in 1961. There is now a strong move to give the Canal national park status and so provide funds for its restoration and preservation. Secretary of the Interior Walter J. Hickel has added his wholehearted approval for the legislation.

A great deal of time and anticipation went into planning our adventure. We wanted to travel as lightly as possible, so we decided not to take camping equipment but line up places to spend the night in towns that adjoin the towpath. We planned to start our trip at Cumberland and ride downstream, hopefully covering about 30 miles a day. Our first stopover had to be Paw Paw, West Virginia, since this is the only Canal town 25 to 30 miles from Cumberland. Our next overnight stops would be in Hancock, Williamsport, Shepherdstown, Harpers Ferry and Whites Ferry.

We made several advance trips by car to these towns, looking for motels, tourist homes or kindhearted souls who would take us in. At Paw Paw there were only a

A research assistant in microbiology, Mrs. Geary penciled notes for this her first story while pedaling behind her husband. Both hail from N.C., but so far apart they have different accents.

Photographs by Colonel John M. Geary

Dripping but brave, the Gearys mount their tandem. It has five speeds, hits 20 m.p.h. on pavement, averaged nine on the path and wore out two tires.

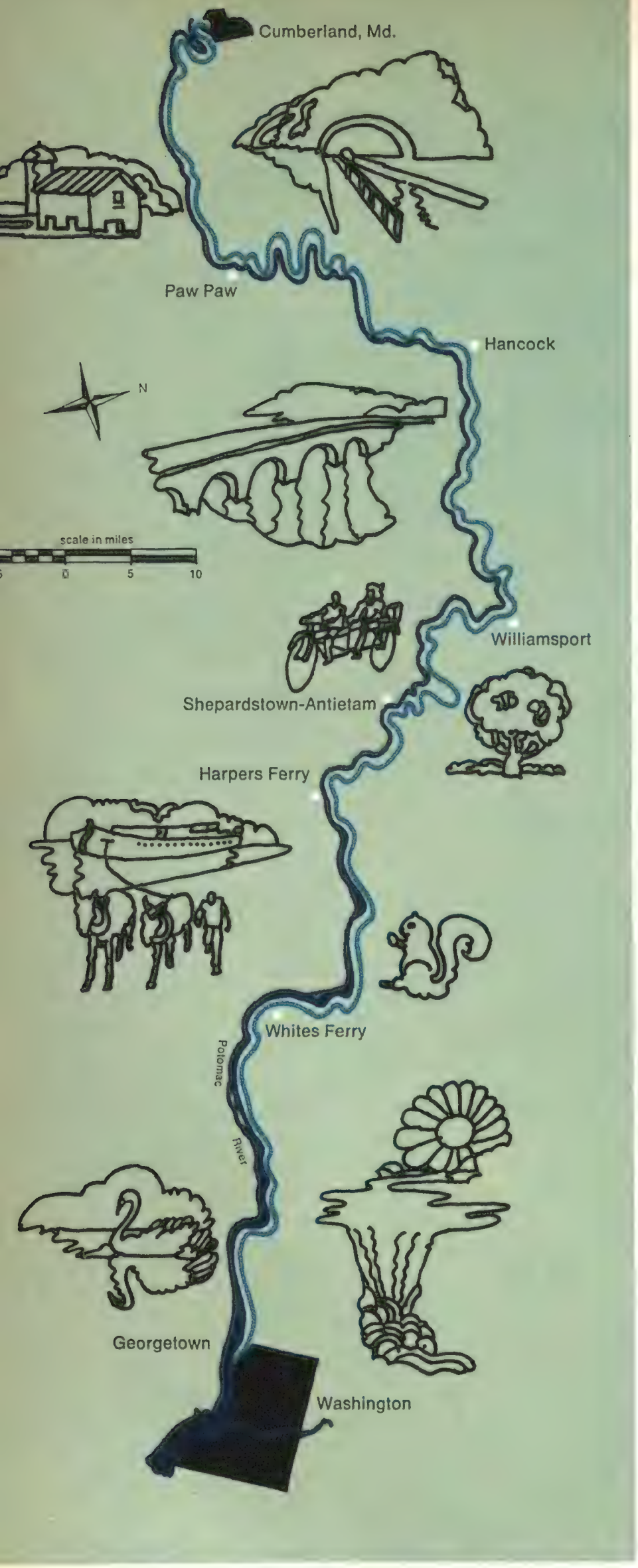
few houses, a post office, a café and a service station whose attendant suggested we ask Mrs. Margaret Golden for lodging. She proved to be our first kindhearted soul. We found motels in Hancock, Williamsport and Harpers Ferry that were not too far from the towpath. In Shepherdstown, a quaint college town, we were not so lucky. We scoured the countryside and at a small neat farmhouse, quite close to the towpath, found our second kindhearted soul. The only other place to line up was Whites Ferry where one of the few remaining cable-guided, fresh-water ferries on the east coast operates. We chose a fishing cabin and now were all set.

How to pack a bike

What to take, or rather, what not to take? I always travel with half my closet neatly packed into several suitcases, a makeup case, shoe case, and anything else I can get away with. Obviously, this was out. We settled on cardboard boxes that would fit into our metal baskets. Jack waterproofed them and we took large plastic bags to encase them in the event of rain. We took the clothes on our backs and one change, with the hope of doing a little hand laundry on the way. We each took an extra pair of shoes and slacks, as well as sweaters, jackets and ponchos. We rolled our clothes and stuffed them into the cardboard boxes, the overflow going into two old musette bags that we snapped on to the baskets like saddlebags. We fastened our canteen of water to the rear. A few cans of Vienna sausage, deviled ham and the like would serve for our first lunches, and we could buy more along the way. We also carried a spare tire and tube, bicycle pump, toolbox and first-aid needs, including a snake-bite kit. Jack, with his military training and natural foresight, never overlooked a single contingency. I think he even carried a list of our next of kin. When everything was loaded our gear weighed more than 50 pounds, not including our camera equipment.

Friends drove us up to Cumberland one Sunday morning late in September, our tandem on a rack at the rear of the car. The air was wonderfully soft and fresh. The roadside where our friends let us off was bright with brown-eyed Susans. The road bisected the towpath here, two miles from the path's true ending. We decided to be honest Johns and go upstream to the very end. With a final wave we blithely pushed off.

The path was rutted and overgrown with grass and we found that with the extra load it wasn't like breezing along on a carefree weekend jaunt. Guiding at first



C&O Canal historical park, as now envisioned, would add to its present average width of 150 feet. Author's overnight stops are shown.

was difficult and we really had to push on the pedals. Of course guiding was not in my domain. The first thing the person who rides in the number two position of a tandem must do is abandon himself to the mercy of the man up front. I couldn't guide, nor did I have brakes. I could only pedal like mad and backseat drive a bit. It was a case of total commitment; whither thou goest I go, whether it looks safe or not.

The path began dwindling off. The waterless Canal was only a slight depression in the land; then suddenly it stopped. Just a smooth grassy meadow lay ahead where boys were playing football. We halted and looked at this unimpressive ending of an ambitious project, then we wheeled the bike around and began our journey.

Oh, but it was a lovely day, and we felt ready for our adventure—alive and strong. We had conditioned ourselves well in the weeks before, and the 28 miles to Paw Paw made a beautiful ride on a smooth path, with now and then the Potomac glistening through giant sycamores and oaks.

Canalboats could barely fit locks

When we had been riding about ten miles we came to Lock 75, last lock on the Canal but our first. Most locks are now in poor repair with a little water flowing over their rotting timbers. In their day they could raise or lower a barge eight feet. Going upstream, barges were lifted from sea level in Georgetown to 605 feet at Cumberland. These mule-drawn vessels were 92 feet long and 14 feet 6 inches wide. Since the locks were only 15 feet wide it was a tight squeeze going through.

The barge captain and his family lived on board, frequently with a dog or a cat or two. When two barges met, one had to drop its towline, so it was unhitched from the mules and pulled aboard. When the other barge had passed, the waiting captain would tie the line to his dog which would swim over to the towpath with it so it could again be hitched to the mules. Young boys often drove the mules. They worked in shifts; one team pulled for six hours while the other took it easy on the barge deck.

Prior to 1850 the barges hauled corn, lumber, lime and whiskey. After 1851 cargoes were mostly coal from the rich coalfields in Cumberland. Sometimes as many as 80 barges lined up at the Canal's Washington end, waiting to unload. During the heyday of the Canal's prosperity, as many as 540 barges were in operation along with 3,000 mules. In winter the big ditch was often drained except for around Georgetown, where the water was used for power for factories and mills.

The locks were taken care of by lock tenders. They were on duty 24 hours a day, made about $150 a year and were provided with an acre of land and a house.

Some locks became known by the tender's name. Lock 67 was called Darkey's Lock and was famous for Mr. Darkey's seven redhaired daughters. On one lockhouse we found—chiseled deeply in the stone block—this declaration: "D + R, 1843." All four edges of the block were lovingly decorated with crisscrossed stars. A scrawl below this scratched in with a sharp rock proclaimed: "Ricky Moats, 18,000 B.C." We dismissed this one as not being too authentic.

Flowers and shrubs grow around many lockhouses, remnants of some long-ago plantings. A huge lilac bush stood alone at Lockhouse 69, planted, I imagined, by some lonely lock tender's wife and perhaps her only memorial. I must return there one spring to see if the blooms are purple or white and silently salute the long-ago planter.

We found several families living in the lockhouses. Isaac T. Long, for example, a retired railroad worker, has lived in one with his wife for the last 27 years. The Longs came out to greet us as we pulled up and asked us to sign their logbook. Their lockhouse, they said, was the last one built before the 1924 flood. The towpath traffic of Boy Scouts and bird watchers, hikers and cyclists parading by their door every day has made their life interesting and exciting. Mr. Long and I walked through his gnarled apple orchard picking up fruit and talking quietly. Then they stuffed our saddlebags with apples and waved goodbye.

Lock gates near Dam 4 guard only a pastoral pool. Here upstream barges took a giant step up to join the river—flowing higher than the canal.

Two ducks and a woodchuck

Now the afternoon shadows were growing long. Ahead a woodchuck, late for his supper, waddled up the path. A thin layer of pale green algae covered the water in the Canal, and a few valiant water lilies struggled through it. Around the next bend were two white ducks, heads curled on their backs, asleep in the late afternoon sun.

We had been really slugging along for the last hour, wondering if Paw Paw was only a fantasy, and getting a little anxious since it was almost dark. Our legs felt the strain of this first day and our derrieres were numb. Then through a break in the trees we saw the highway bridge. We turned off the path and pumped up the long hill that led to Paw Paw and hopefully a hot bath, food and a soft bed. When we finally dismounted at Mrs. Golden's, I knew what the poet meant when he spoke of: "Two vast and trunkless legs of stone." We were not sure when we put a foot down that it would land where we had intended. Not finding Mrs. Golden at home, we walked stiffly over to the café for the key, as she had directed. Gladys, who had worked for Mrs. Golden for years, returned with us, looking us over to see if we would "do." I guess we passed inspection. We desperately wanted to soak our poor muscles in a tub but Gladys informed us that the café would close shortly, so off we went, dust and all and ate an enormous steak dinner. Before we finished, a small group had gathered around our table, full of friendliness and curiosity about our trip.

Back at the house Mrs. Golden made us feel as if we were old friends. We must come and have some cantaloupe, and she knew we must be tired, and shouldn't we put the bicycle inside the porch so it would be safe? That evening she reminisced about old days on the Canal. She recalled walking along the towpath with her beau when along came a barge and gave them a lift home. It was late when we put our aching legs to bed.

The next morning, Monday, found us skimming down that same long hill, our legs feeling strained, but better. The tops of the hills around us were shrouded in mist, and our fingertips tingled with the cold. But by the time we got back on the towpath the sun had burned through and felt warm on our backs. Soon Paw Paw tunnel loomed ahead. It was built between 1836 and 1850, cutting 3,000 feet through a mountain. I wasn't too excited about entering it. I have a "thing" about tunnels—especially dark, carved-out-of-the-rock ones like this. Yet I knew we were committed so I gritted my teeth and we started through. Soon our bike headlight, even supplemented by a flashlight, wasn't enough to see, so we got off and pushed. I mumbled something about the darkness. Jack said that if I took off my dark glasses it might help.

The only sounds were the plod-plod of our shoes on

At the winch house at Dam 4 wooden gates could be lowered to check flooding. Towpath passes under building—now a museum.

Swains lockhouse, still lived in, sprouts TV antenna. Park service concessionaire uses the wooden building for renting boats.

the gravel-covered stone walkway and the drip-drip from overhead bricks. When we emerged, the sun looked brighter, and every tree, rock and puddle seemed larger than life. A wooden boardwalk extended from the tunnel, crossing huge boulders. The towpath here was quarried out of solid rock, a 200-foot wall paralleling the path on one side. Tiny lavender flowers grew in the rock crannies high above us, and beyond, the mountains rose. It was a wild and wonderful spot.

Soon the river came back into view. It was very quiet here. Except for the distant cawing of crows and the pinging snap of a twig against our tires, there wasn't a sound.

At Lock 62 we came to Sorrell Ridge, one of many Hiker-Biker-Overnighters on the towpath. These are camping areas cleared and maintained by the National Park Service. Most have toilets, pumps and picnic tables. It was good to sip cool water from an old-fashioned iron pump after our rather stale canteen water.

Grim memento of Antietam

At Lock 59 a giant sycamore has a rusted gun barrel possibly of Civil War vintage locked between its stark white limbs. During the Civil War, Southern troops tried unsuccessfully to destroy the dams which supplied water for the Canal. Robert E. Lee, after Gettysburg, was near surrender when he was forced to remain in Williamsport because of the flooded Potomac. And then there was the bloody battle at Antietam Creek where thousands were killed. Standing now under the ancient sycamore, we found it hard to imagine all that death and struggle.

Death and struggle were part of the building of the Canal, too. Rival clans of Irish and German laborers fought and many died of cholera. In St. Patrick's churchyard, at Little Orleans, we saw the graves of laborers and their families. As we got back on the path a whole flock of goldfinches like bright bits of sunlight flew up from the trees and then were gone.

We had been pedaling along and watching some fishermen on the Potomac when we became aware of a high rocky hill on our left. About 75 feet up was a concavity, an anticline, like a great unblinking eye. Devil's Eyebrow, it's called. I scrambled up and sat inside it. Nearby are entrances to abandoned mineshafts —extremely dangerous. I slithered down from Devil's Eyebrow, rock dust flying, with Jack at the bottom to catch me.

Soon after, dusty and bedraggled, we pulled off the path to go into Hancock for the night. Of course we had to get off and push up another long hill to the motel. We found our room quite small, what with our gear and the bicycle, all nine feet of it, but I could have slept in a crack that night.

As we left Hancock, heading for Williamsport, we finally felt that we had gotten our "legs." It had taken two days of tough seasoning, but now the aches and cramps were gone and we felt good. There was water in the Canal along here, and the thin film of algae cracked into a wild mosaic as water bugs skittered

Lockhouse at Spinks Ferry is built of stone—typical Canal construction. Seventy-four lift locks raised barges 605 feet on the way to Cumberland.

An unusual curtain shields the window of a farmhouse bordering the Canal. Barge mules were boarded with farmers during the winter.

across it. Sometimes the surface was entirely unbroken and I felt as if I could walk on it without sinking.

At Big Pool, the Canal diggers got a brief reprieve for here was a wide natural depression which they had only to fill with water and presto: instant Canal. Now young elms grow close to the path with surface roots making a corduroy surface. The wide water here looked like a peaceful lake, but the sun perversely went behind some clouds so it was impossible to take the picture we wanted.

Anything for a picture

When we reached the end of Big Pool, jogging our teeth loose on the roots, the sun came back out. Jack said, "Let's go back."

"Whither thou goest—," I said.

We turned and rode the two miles back over the roots and got the shot. But after all that, it wasn't worth the effort.

To be fair, the man in the number one seat did have a few functions other than being undisputed leader. He served as cobweb breaker, gnat catcher and, if you will, hood ornament.

About midafternoon we began slowing down. We have read that six-day bicycle racers sip water laced with lemon juice to refresh themselves, but we found that several squares of bitter-sweet chocolate gave us that extra spurt of energy we needed when the level towpath seemed to be going uphill.

People in Williamsport are used to Canal travelers so we caused only a slight stir among the townspeople when we came off the towpath and rode up the main street—and I do mean *UP*. We had to push up steep hills for about two miles to our motel. I simply collapsed on the grass outside.

But it was a splendid whirling, flying, mad descent down those hills the next morning, dodging school buses and early-morning pedestrians and landing finally in Jeanie's Confectionary for breakfast. We ate hurriedly for we were going to visit Mr. "Hooper" Wolfe, author of a recent book, *I Drove Mules on the C and O Canal*. We found him in his apartment over his store, a sprightly gentleman of 75. He started driving mules on the Canal when he was ten, earning $8 a month. At 19 he married a barge captain's daughter and quit. He published his book himself and is now taking orders, mailing it out, and supervising a second edition. It's a delight, full of anecdotes about the customs and folklore of that era.

We started late from Williamsport on our fourth and what proved to be our roughest day. At a place called Falling Waters the guidebook advised that we leave the towpath and take a detour around rough terrain. But detours were for "trepid" travelers, so we decided to forego it. We had reason to question that decision. The water just above Dam Four was deep enough to float barges so no canal was dug. A path for the mules was cut out of solid rock. They must have been skinny mules for the path was very narrow between a sheer rock wall and the river. We had to push over most of this three-mile section, but now and then

Bicycling the towpath

we would feel brave and mount up. Once when we were feeling daring, the path took a downward plunge. Our momentum threw our feet off the pedals, and for a minute we headed straight for the Potomac. Then Jack regained control and we shakily got off and pushed again.

Around one bend we were confronted by an enormous rockfall. Rather than unload our 50 pounds of gear, we lifted and tugged and pulled our bike over. We realized that we had just passed the midpoint of the towpath, but we were too exhausted to celebrate.

About three miles above Shepherdstown there are many caves looking like huge pockmarks in the high rocky hill bordering the path. One of these is Killiansburg Cave where, it is said, many women and children took refuge during the battle of Antietam.

We pulled off the towpath at Mountain Lock, a recreational area, and came out on a country road that led uphill, of course, to our lodging at Mr. Iseminger's farmhouse. Our host met us, trailed by three cats. He was tall with close-cropped white hair, and he had flowers everywhere to welcome us. He plied us with hamburgers, huge slices of red and yellow tomatoes and homemade applesauce.

Next morning we awoke to rain on the tin roof, one of those steady downpours that usually last all day. Fortunately we had only planned to go to Harpers Ferry, a distance of seven miles. We broke out our ponchos, and Mr. Iseminger gave me a small jar of his own apple butter as a parting gift. Jack got a stirrup cup of homemade grape wine (Mr. Iseminger said, "I wouldn't presume to offer the lady spirits").

At first, as we pedaled along, the rain was rather pleasant. It fell softly and the trees looked as if each leaf had been polished. I was enjoying it all and thinking of it as part of the Total Experience. Then it began to pour harder and harder. Rain streamed down my face like a waterfall, while Jack yelled, "Keep pedaling." The last half mile to our motel across from Harpers Ferry was the roughest. We left the towpath, pushed up an embankment to the railroad tracks and lifted and bumped the bike across to get to the road that led to the highway that led to our motel. All this time I was aware of an old man sitting on a dilapidated porch, swigging on a bottle and watching us with complete detachment.

When we left the motel early next morning we were still a little soggy, but the rain was over and the clouds were high-flying mare's tails. Mist lingered over the craggy cliffs. Back down the highway and over the tracks we went. The old man was still sitting on the porch with his bottle as if he had never moved.

That day we saw our only snake while we were having lunch on an old fishing wharf. He was swimming across the Potomac, and we were amazed at how swiftly he came and how the current had no effect on his course. He reached shore and slithered away.

As we neared Whites Ferry the canal was clogged with fallen trees. They made wonderful places for sunbathing turtles. At our approach they dived into the water domino fashion. And suddenly three full-grown wild turkeys ran ahead of us along the towpath, then melted into the brush.

We take a spill

The path had turned into two deep-rutted tracks in the mud. A Boy Scout troop overtook us on their single bikes. Ours, being twice as long, had a tendency to fishtail in the slick parts, and thus we took our only fall of the trip.

Mud was splattered up to our hips when we pulled into Whites Ferry. Retrieving a cache of provisions and gear that we had previously left with the caretaker, we parked in front of our cabin. When we left next morning we had company—Tramp, a sleek black Labrador, resident dog at Whites. It was a beautiful clear morning and Tramp ran ahead of the bike, black plume of a tail flying, scaring up whirring flights of wild geese from the Canal. He finally joined a Boy Scout troop and headed home. So, it was our last day, with 35 miles to cover. We were like horses eager for the hay and the home barn. The trail was good. We whirled past Seneca and Swains Landing, the path getting more and more crowded as we neared Great Falls. We rode for a while with Boy Scouts making their 35 mile badge; *we* had almost 184 miles under *our* tires. We pedaled through Georgetown, within the District of Columbia, and down to the really-and-truly end of the path at Tidewater Lock.

There our 20-year-old daughter met us with the car. "Hi, Mom," she said, "you look awful!"

A sudden antic processional through an arboreal cathedral turns out to be Boy Scout cyclists wheeling exuberantly along the towpath's leafy corridor.

While scientists study enzymes, phosphates and substitutes, manufacturers are caught between those who enjoy easy washing and a part of the public that accuses them of being soilers.

By Kenneth M. Reese

Detergent debate: Are work-savers helping to ruin our waters?

Chemistry of eutrophication is little understood but it is suspected that discharge from washing machines is a chief cause

Sometime in the dim past the housewife took over management of home and husband, and running the laundry was part of the deal. River banks gave way to town pumps and public tubs, public tubs to home washboards, and washboards to washing machines. Work became easier, and the introduction of modern laundry detergents was an important step in the process. The modern automatic washing machine was designed to work with detergents.

But problems with detergents keep coming up. First there was foaming in rivers and lakes and even tap water at home. The detergent industry solved that problem. Now it is the phosphates in detergents that are being accused as pollutants. Although there is disagreement on their effect, many say that the phosphates cause the eutrophication in lakes and streams that plugs them up with algae and causes their decay. For the second time in a decade the detergent industry is deep in an environmental imbroglio, and the housewife is warned away from some of the products that ease her work.

Scientists do not yet understand eutrophication in detail, but it is a natural growth and aging process that, unaided, proceeds only over geologic time. The current problem is accelerated eutrophication, supported by nutrients supplied by man.

Lieutenant Commander Reese, retired, is a chemical engineer and was formerly managing editor of Chemical and Engineering News.

As nutrients accumulate in a body of water, algae and other plant life proliferate. Fish and plants die, decay and return nutrients to the water. Lakes lose their recreational value as decay reduces oxygen levels in the water, more fish die and algae clog the water and pile up on the beaches. Foul odors develop. Plant life clogs the intake lines of the treatment units that produce public water supplies. The body of water fills slowly with organic debris, becoming first a bog and eventually dry land.

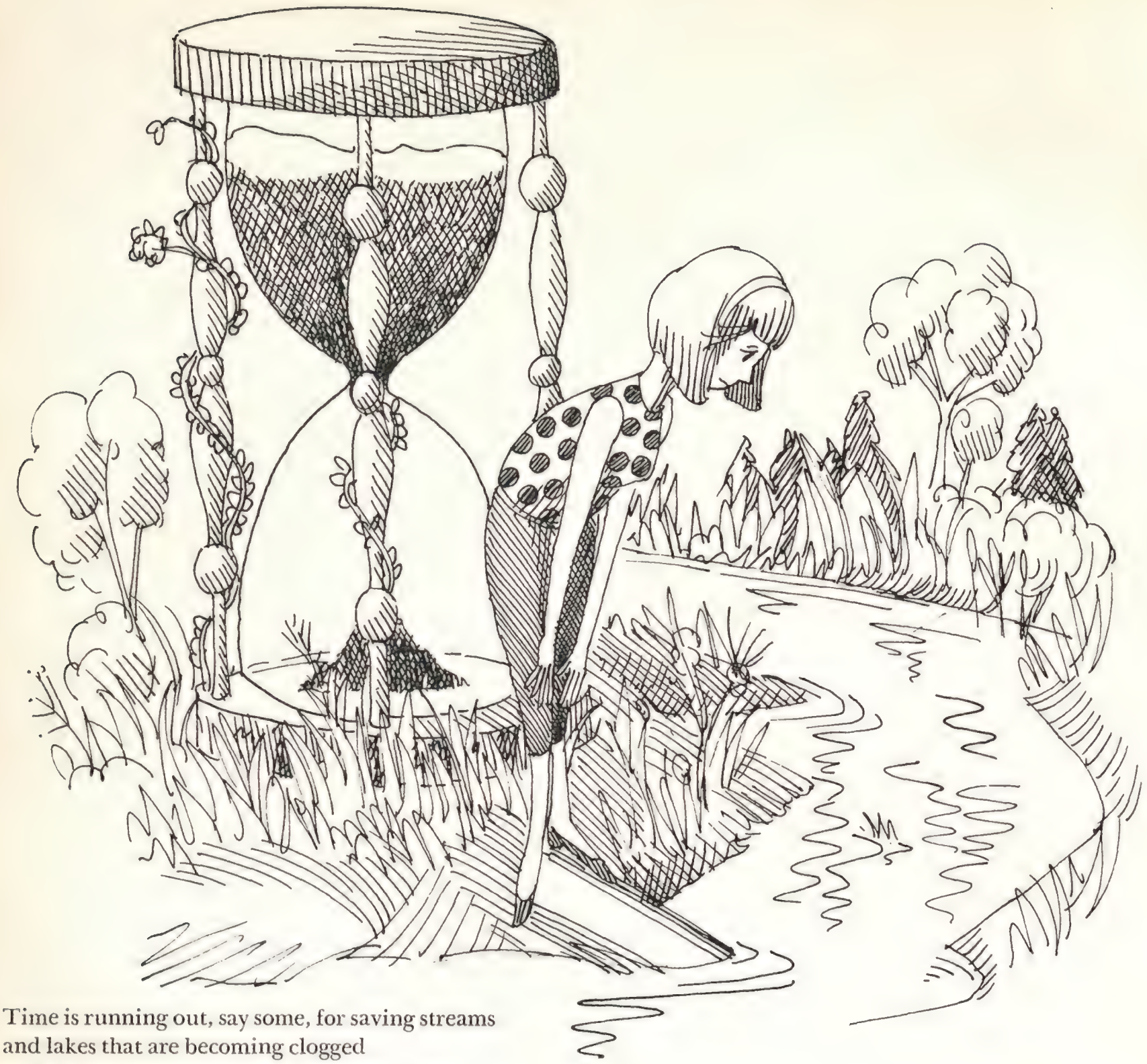
Some suspicions are aimed also at detergent enzymes. These are proteins that break down protein stains such as those caused by milk, chocolate and blood. They also break down proteins that bind non-protein dirt to clothing.

Compared to the phosphate question, though, the current flurry of activity over enzymes seems not to be a major issue. Workers exposed to high concentrations of enzyme dust in detergent factories have developed dermatitis and flu-like and asthmatic conditions, but dust control in manufacture can cure this problem. Presumably the housewife is exposed to concentrations too small to cause such troubles.

Back to soap and washing soda?

The housewife can shelve the detergent box and turn back to soap and washing soda as some have been doing. If she does, however, she may lose some of the advantages of machine washing. Moreover she may have to wait a number of years to see if the natural waters clear up.

The consumer will find the industry's explanations earnest but sometimes confusing. Earlier this year full-page advertisements by Procter & Gamble addressed themselves to the situation and P&G's position. Lever Brothers added a booklet that covered the technical



Time is running out, say some, for saving streams
and lakes that are becoming clogged
with great and unexplained growths of algae.

ground and Lever's stance, and included along the way a faintly commercial note on P&G.

The P&G ads said in part that by May of this year the company would be using a new chemical, sodium nitrilotriacetate (N.T.A.), to replace 25 percent of the phosphates in about a third of its laundry detergent volume. A good thing, too, the Lever booklet implied. The action, Lever claimed, would reduce the average phosphate content of P&G's products from above the industry average, roughly 45 percent, to about the 37 percent already used by Lever. Lever Brothers has since revealed that it, too, is replacing part of its detergent phosphates with N.T.A. A phosphate-free, N.T.A.-based version of Lever's "Cold Water All" liquid detergent is scheduled to be available this month. N.T.A. will partially replace phosphates later in dry products, although it may turn out that N.T.A. has some undesirable effects, too.

A soap-and-soda crusade started with Pollution Probe, an activist group at the University of Toronto. The soda makers are aware of a new source of business. As the opening shot of a vigorous promotion salvo, a "Memo to Earth Day Press" from the public relations agency for Church & Dwight, makers of Arm & Hammer washing soda, told all about soap and soda; it was complete with washing instructions for the phosphate-conscious housewife. The Church & Dwight news release said that "throughout [Canada] women

are scrapping their . . . laundry detergents and switching to a combination of soap and washing soda—all in the name of water pollution." Canada, in fact, is limiting phosphate content, and it is predicted that there will be a complete ban within three years. The United States, of course, shares certain waters of the Great Lakes with Canada.

The House Subcommittee on Conservation and Natural Resources, headed by Representative Henry S. Reuss (D.-Wis.), who is leading the antiphosphate forces in the Congress, is studying the issue.

Reuss's subcommittee held hearings on detergent phosphates last December; in April its report was approved and adopted by the parent Committee on Government Operations.

The U.S. detergent industry, through its spokesman, the Soap and Detergent Association, had its say in the subcommittee hearings. The Association said that if phosphates were removed from detergents housewives "would find it virtually impossible to continue to enjoy the cleaning benefits of the modern automatic clothes washing machines. . . ." Reuss called the detergent industry "the Nation's No. 1 polluter." The subcommittee report recommends that detergents be essentially free of phosphates by 1972 but suggests an extension if the industry can prove that it needs more time "after good-faith efforts to eliminate phosphates from detergents." Sharing these sentiments is the Federal Water Quality Administration, which wants "a reduction of phosphate levels in detergents . . . immediately, and the complete replacement of phosphorus compounds in detergents with less environmentally harmful substitutes as soon as possible."

None of these recommendations has the force of law, but ten bills now pending in Congress are directed at the phosphates.

The industry questions the technical basis of the subcommittee recommendation. It can logically be expected to fight a holding action designed to bring the phosphate problem under control at least cost to itself. It will very likely fight to delay the total elimination of phosphates and dig for the scientific evidence that would justify retaining some portion of them. Nevertheless, the companies say that they are working hard to find replacements.

Before phosphates, it was foaming

The situation is ironic. Synthetic detergents are a solid technological achievement, even granting that the nation might have rolled along reasonably well without them. They have hardly been shown to threaten the public health directly. Quite the contrary, since their fundamental purpose is sanitation. And yet the detergent makers find themselves once again under fire for soiling the environment.

Investigation of earlier foaming showed that detergents were the cause. Reuss and others applied congressional pressure to the makers. No federal legislation was passed, but in 1965 the industry changed its products at a stated cost of $150 million, and the foaming they caused came gradually to an end. Today the makers tell the housewife that the change was voluntary. Some of the legislators, including Reuss, say that the change would not have happened, or at least not nearly so soon, had they not turned on the pressure. The truth probably falls somewhere in between.

The love affair between synthetic detergents and the American housewife started just after World War II, and from that time on soap steadily lost ground. Women today buy detergents five-to-one over soap. Of the 5.5 billion pounds of synthetic detergents sold in this country last year, roughly 85 percent was for household use, and roughly two-thirds of the total was laundry products.

Why synthetic detergents work so well

Synthetic detergents defeated soap primarily because they wash better in hard water. Hardness varies widely and depends on the water's content of dissolved minerals, mainly compounds of calcium and magnesium. These minerals are the main target of the phosphates in detergents. (Municipal water-treatment plants soften water for perhaps ten percent of the U.S. population. But some of the hardness is left in water because it creates a corrosion-resistant coating in the treatment and distribution system.)

Both soaps and synthetic detergents are based on surface-active agents, which markedly improve the ability of water to penetrate fabrics and remove soluble dirt. Also they loosen, make soluble and suspend oily and insoluble dirts so that they will wash away in the water.

Household soaps consist largely of surface-active agents, but synthetic detergents contain only eight to 25 percent of them. The surface-active agents in soaps —sodium stearate is a common one—are made from natural products such as tallow and coconut oil. Those in detergents are made chiefly from petroleum, and the most common one is linear alkylate sulfonate (L.A.S.), an organic chemical that contains carbon, hydrogen, sulfur, oxygen and sodium.

Constituents of soap, such as sodium stearate, react with the calcium and magnesium in water to form compounds that pick up dirt in the water and settle out as grayish curds on clothes. The soap cannot begin to clean until enough has been added to react with all of the calcium and magnesium. The surface-

active agents in detergents would behave in the same way if the phosphates were absent. The resulting compounds would remain in solution instead of forming a scum, and they would still be surface-active agents, but they would not clean nearly so well as the original L.A.S.

Not all of the hardness in wash water originates naturally. Some can enter with the dirt on the laundry. The dirt may also contain compounds that, like the sodium stearate in soap, form curds in hard water. But regardless of the source of the hardness, it must be dealt with in some way for a clean wash.

The housewife can boil the water and remove some of the hardness. She can add washing soda, which removes all of the hardness if she uses the proper amount of it. She can use extra soap, which is a softening agent itself, but removes the hardness in the form of undesirable curds. Such methods were common in the days when soap was king, but synthetic detergents have made them mostly memories.

The phosphates in detergents tie up calcium and other metals in soluble form and prevent them from interfering with the washing process. The phosphates also disperse and suspend dirt and perform other secondary tasks. Laundry detergents vary from 20 to 60 percent phosphate (or more in presoaks), measured as sodium tripolyphosphate, the one most commonly used.

There's more to a detergent than just suds

Besides surface-active agents and phosphates, detergents may contain small amounts of other ingredients: corrosion inhibitors, compounds that supplement the phosphates, suds-control agents, dirt-redeposition inhibitors, bleach, bacteria inhibitors, bluings, colorings, fabric brighteners and, in the past few years, enzymes. Liquid detergents may contain up to 50 percent water, the vehicle for the active ingredients. Solid products may contain 10 to 20 percent sodium sulfate, a by-product of the process used to make the surface-active agent. The sodium sulfate could be removed, but doing so would raise costs to both producer and consumer.

The synthetic detergents are cheap; they work well; they are convenient. Detergent advertising may not be universally loved, but it seems to do the job. Detergents were outselling soap less than ten years after World War II, and it was clear by then that they would be around the home for awhile.

Soon it was also clear that they would be around the environment for awhile. Detergent-caused foaming was the first sign; shortly afterward came eutrophication and the accusation that detergents were mainly responsible for it.

Eutrophic conditions prevail in parts of Lake Erie and Lake Ontario and in the Madison lakes in Wisconsin. Lake Washington, at Seattle, was eutrophic but has started to recover since the sewage that carried nutrients into the lake was diverted elsewhere. Lake Tahoe, in California and Nevada, has shown scattered early signs of eutrophication; as insurance for the future, treated sewage is now pumped entirely out of the area. Eutrophic conditions exist elsewhere in the nation, but the problem is not yet truly nationwide. It is nevertheless serious where it does exist, and the steady growth of human activity will do nothing to help the situation.

Nutrients speed eutrophication

Eutrophication depends on the complex interplay of a number of factors, but man's only practical point of attack is the nutrient supply. Aquatic plants require large amounts of some nutrients, such as carbon, phosphorus and nitrogen, and only traces of others. They utilize nutrients in fixed proportions. Thus plant growth is limited by the nutrient that is present in the smallest amount relative to the proportion required. This one is called the limiting nutrient.

To see what we mean by this term, consider a buggy maker who puts together wooden wheels using rims, spokes and hubs. He can keep on making wheels until he runs out of one of the parts. Perhaps he runs out of spokes while he still has plenty of rims and hubs left. Then the spokes have become his limiting ingredient. He can make more wheels when he gets more spokes, and he can make wheels as fast as the spoke maker can supply spokes to him.

So it is with the limiting nutrient. Any nutrient that is present in oversupply has no significant influence on the growth of plants and algae, and the larger the

concentration of any particular nutrient, the less likely it is to be the limiting one. Often the limiting nutrient is phosphorus, but not always. In Lake Tahoe it is nitrogen. In some other situations scientists are growing extremely suspicious of carbon.

It is not easy to determine which nutrient is in fact the limiting one in a body of water. A good deal of evidence, for example, suggests that the limiting nutrient in Lake Erie is phosphorus, but by no means all scientists view the evidence as conclusive. Despite such perplexities, most argue that it is a sound risk to curtail sharply the discharge of phosphorus into the nation's waters. The issues are whether the risk is sound enough to justify removing the phosphates from detergents—with the consequent economic penalties —and whether a substitute will be satisfactory.

It is easy to see why detergents have become a conspicuous problem. They supply some 65 percent of the phosphorus discharged in the nation's sewage, whether treated or not, according to estimates by the Federal Water Quality Administration. Human wastes supply the remaining 35 percent. An estimated total of 60 million pounds of phosphorus enters Lake Erie annually by way of municipal wastes, land drainage, inflow from Lake Huron and industrial wastes (in descending order). Of this total roughly 40 percent of the phosphates is from detergents.

The Soap and Detergent Association contends that the phosphorus discharged in sewage would best be abated by upgrading the nation's sewage-treatment facilities. The Federal Water Quality Administration is pushing such a program, but as part of a massive attack on all water pollutants, not just phosphorus. The program visualizes widespread expansion of conventional sewage-treatment processes: primary treatment, which involves physical removal of solids, grease and scum; and secondary treatment, in which microorganisms break down organic matter as they do in nature. Primary treatment removes only about ten percent of the phosphorus in sewage, and primary plus secondary treatment averages about 30 percent removal.

Improved sewage treatment is needed

Other, little-used processes can remove more than 95 percent of the phosphorus, and the Federal Water Quality Administration is urging their use in areas where phosphorus pollution is a problem. The administration estimates that to raise U.S. sewage-treatment capacity, including phosphorus removal facilities, to a desirable level would cost $9.9 billion in 1970-74. But there is no likely chance that the upgrading and expansion of sewage treatment facilities will have drawn abreast of the need, which is growing steadily, by the end of 1974.

Meanwhile, phosphorus discharges in sewage, whether treated or not, could be cut back sharply by removing part or all of the phosphates from all detergents.

The industry argues that the case against phosphates is not strong enough, scientifically, to warrant removing them from detergents. For one thing, a eutrophic lake already contains large amounts of phosphorus and other nutrients. It might remain eutrophic for years, even if all outside sources of phosphorus were sealed off and if phosphorus were the limiting nutrient. Many natural waters, moreover, are not eutrophic at all, the industry points out, and would not benefit noticeably from a cutback in detergent phosphates.

Despite their stated doubts, the detergent companies recognize the realities they face. The temper of the times is not to wait for conclusive proof of harm before striking at an environmental contaminant. The proof may be too long coming. The industry also is intensely conscious of what the public thinks of it. It has no wish to be run down by the somewhat emotionally propelled environmental bandwagon. Thus the companies are working hard on replace-

Because the combination has no phosphates, soap, with soda as a water softener, seems less harmful in the drainage than detergents.

ments for the phosphates. Procter & Gamble, bellwether of the industry, says it "is engaged in an 'all-out' effort to reduce—and eventually eliminate—the phosphate content of its detergents."

Here is the role of N.T.A., which the industry is beginning to substitute for phosphates in its detergents. Like the phosphates, it ties up calcium and other metals and prevents them from interfering with the washing process. But despite P&G's and Lever's current use of it in laundry detergents, including "Cheer" and "Cold Water All," neither company nor their competitors are certain at all that it will be the complete answer.

N.T.A. absorbs moisture readily. The housewife who opened a box of detergent powder formulated entirely with N.T.A. might find herself with a single, box-sized cake. It also tends to attack metals in the washer. Solving such problems may not be easy, but doing so is well within the reach of modern chemical technology. P&G (probably others too) evidently has solved them in powder formulations in which N.T.A replaces up to 25 percent of the phosphate.

The more difficult questions about N.T.A. concern its environmental effects. The compound already has been studied at length in the detergent industry and elsewhere, and no real problems appear to attend the current level of use, roughly 100 million pounds per year. Were N.T.A. to replace phosphates completely, however, the amount used would approach 1.5 billion pounds per year, and no one can tell how that situation might be different.

N.T.A. is toxic at large enough doses. But as the chemical is used in detergents, the likelihood of anyone's ingesting a lethal dose is remote. Even a child who ate a lot of detergent would not hold it down; the emetic dose of the detergent is much smaller than the fatal dose, mainly because of the surface-active agent. The crucial questions relate to the small amounts of N.T.A. that might accumulate in the environment if the chemical were used in many times the current amount. It is biodegradable in sewage and natural waters, but not quite so readily as other organic matter. At a very high level of use, significant amounts of the chemical might enter natural waters and there remain undegraded for long periods.

Were that to happen, traces of the compound could enter public water supplies and exert long-term, low-level effects on humans. N.T.A. could corrode water supply systems (inhibitors in the detergent formulations protect washing machines). It could tie up traces of nutrient metals, improving their use by aquatic plants and thus contributing to eutrophication.

The possibility that these sorts of things would occur may not be great. But today, even the seemingly far-out environmental questions must at least be asked. This is true not only of N.T.A., but of any compounds that might be used in huge amounts to replace the phosphates. The required research is under way on N.T.A., but nobody yet has all the answers.

So what is the housewife to do? If she wants to do something at once, she has several choices. She can switch to soap and soda. She can switch to soap and a home water softener. She can beat the drums for more and better sewage treatment plants. She can send her views to Reuss, to her own congressman and senators, and to the detergent companies.

The soap and soda recipe

To use soap and soda, the housewife need only follow the instructions: Put clothes in the machine and fill with water; add ¼ to ⅓ cup of washing soda and let it dissolve; add 1½ cups of soap for front-loading machines or 1⅔ cups for top-loading ones; if water is especially hard or soft, adjust the soap to maintain a two-inch head of suds throughout the wash cycle; in hard water, add ¼ cup washing soda to first rinse water.

Chemical and physical conditions in the washer are likely to produce a small amount of soap scum that will settle on the clothes. (In the spin-dry cycle the clothes, in fact, will filter solids from the water that is pushed through them by centrifugal force.) The laundry may thus become a trifle dingy after repeated washings, but soap scum can be removed by running the clothes through a cycle with a non-precipitating water softener. (Soda is a precipitating water softener; the compounds it produces settle out instead of remaining in solution.) These products are based on phosphates, but the housewife would be using them only intermittently. The scum problem cannot be solved by using excess washing soda

although there is no harm in doing so. The textile industry boils cotton fabrics in solutions several times more alkaline than the housewife is likely to produce in the home with washing soda.

On the whole, soap and soda can do the job; women by the million were using them until a generation ago, when they found that synthetic detergents would give them better results with less effort. The housewife's problem today is to decide what she will achieve by reverting to soap and soda. She probably will eliminate about 65 percent of the phosphorus from the sewage that leaves her home, but will the local algae miss it? They may—if enough housewives join her in the switch, if the local waters are eutrophic, and if phosphorus is the limiting nutrient. In fact, though, the algae may thrive with the 35 percent of the phosphorus from human wastes that remains in her household sewage. Only when additional research determines what nutrients the algae need and use can we know the effect of phosphorus.

A home water softener works too

Soap and a home water softener make a nice team, particularly where the water is relatively hard. The softener costs $300 to $500 initially and roughly $10 to $15 per year to operate. Rental is about $30 a month. One uses considerably less soap (or detergent), scale doesn't build up in the hot water heater, and clothes last longer. It is difficult to demonstrate clear-cut savings in the home, however, and Culligan, Incorporated, the leading maker of home water softeners, sells them as luxury items. Culligan, incidentally, sells a laundry soap to go with its softeners. The company astutely removed the phosphate from the formulation in May and reports that the soap is selling splendidly. The effect on eutrophication is similar to that produced by switching to soap and washing soda.

Public demand for better sewage treatment facilities would attack not just phosphorus but water pollution in general. Conventional secondary treatment today is applied to less than half of the sewage generated in the United States. Effective phosphorus-removal processes are used only in a few experimental and demonstration plants. The Federal Water Quality Administration says that community investment in water pollution control facilities last year—$880 million—"did little more than cover replacement and growth needs developed in the same year." It is true that a lot of money can be spent on sewage treatment plants without great effect. All the same, intelligent efforts among the people who must vote on the local bond issues can hardly fail to improve water quality in the long run.

The phosphates clearly are the major environmental issue that confronts the detergent makers and their users today, although enzymes may require continuous surveillance; they have recently come under the watchful eye of Ralph Nader. Solutions to the phosphate problem are emerging, if slowly. Whatever the ultimate solution, the housewife will bring it sooner by being an informed participant in the proceedings. When will it really come? Difficult to say precisely, but the gambling home manager might get reasonably good odds on December 31, 1974.

Man-made nutrients hasten eutrophication, a natural process through which dying plants and animals make ponds into bogs and eventually into dry land.

Article and photographs
by Henry B. Weaver

Animals and Man in East Africa learn to get along

New courses teach the care and preservation of wildlife in a shrinking environment that take for granted people, cars and cameras

East Africa's glorious wildlife is rapidly losing its wildness. As ever-larger armies of tourists have invaded the great wildlife parks of Kenya, Uganda and Tanzania in recent years, birds and animals have grown increasingly indifferent to their presence. In the end, this development may prove to be the animals' salvation. For tourists bring to these impoverished countries desperately needed foreign exchange, some of which is used to underwrite vigorous wildlife conservation and education programs.

On a pleasant Sunday in East Africa's wildlife parks, one is likely to find as many as 20 tourist vehicles parked hard by a pride of lions, a herd of elephants or beneath a solitary leopard snoozing high in the branches of a tree. With any degree of luck, a tourist can photograph impala fighting, lions courting and crocodiles slumbering nearby in the warm ooze of a river bank.

In Kenya's Nairobi National Park one day, I came upon a young lioness which had just feasted upon a zebra. After a short nap, during which a number of automobiles had gathered, the lioness yawned, stretched and strolled away between the automobile bumpers as nonchalantly as a Manhattan matron crossing Fifth Avenue on a green light.

Henry B. Weaver is a Washington corporation lawyer who has long been interested in saving wildlife. He reports on his firsthand observations of new ideas of conservation in Kenya, Uganda and Tanzania.

Giraffe at Murchison Falls National Park, Uganda,
acts as though he owns the place. He does.
Here he is guarded from his worst enemy—Man.

"In all the parks, the animals are becoming less disturbed by the presence of Man," says an official of Tanzania's parks. "They spend longer in the open and are easier to see. The buffalo at Mikumi National Park pose stolidly for closeups, and the elephants at Lake Manyara National Park can be easily photographed with a box camera."

A crisis faces East Africa's wildlife, however. For one thing, the animals must learn to survive in an ever-shrinking habitat amidst largely illiterate peoples whose birthrate is exploding. Fortunately for all of us, the governments of East Africa appreciate their wildlife, and have embarked upon a program to convince their peoples that they stand to gain more by conserving the animals than by killing them, as has been their centuries-old custom.

To this end, the College of African Wildlife Management was founded seven years ago at Mweka, Tanzania, to turn out topflight game and park wardens. Today, nearly 100 students from 12 African nations are attending the school with its one-year basic course and two-year advanced course.

A visitor to the laboratories can find some students examining an elephant skull while, in the next room, others are studying plant material under a microscope. In the classrooms, lessons go on in such background subjects as botany, zoology and geology. Training in conservation education includes the preparation of plans for a visitors' center, building outdoor exhibits and designing signs, as well as training in public speaking.

In electing a career in wildlife management, black African youths must overcome a perhaps natural disinclination to return to the wilds whence their forefathers came. The educated African today prefers carrying a briefcase to carrying a spear. Life in the "bush" provides him with little status. In sum, it will take many years before the "white hunter" becomes the "black hunter."

Even so, the seeds sown by this fine institution have already borne considerable fruit. One of the college's graduates, for example, directs the Wildlife Education Center in Nairobi National Park which provides a four-hour session including films, lectures and visits to the animals' habitat, enjoyed by tens of thousands of visitors a year. Most of them, incidentally, are

Minibus meets maxi-beast at Lake Manyara National Park, Tanzania. Africans and elephants depend on each other for tourism, security.

African children who strangely enough have never seen a wild animal before.

Each visitor to the wildlife center receives a government pamphlet which emphasizes that tourists in Kenya spend millions of dollars every year just to see the animals.

Animals are considered government employees

"Our animals work for us—they are employees of Kenya," says the pamphlet. "They earn money for the country and yet we pay them nothing for this work. Like all workers they must have a place to live and food to eat. This is the major purpose for the establishment of our reserves and parks. If our animals are to continue to work for us, these lands must be respected."

Educational efforts in conservation are not limited to the visitors to the parks or to school children. The government of Kenya also sends mobile film units to remote regions of the country to spread the conservation message, broadcasts lectures over the radio and encourages formation of wildlife clubs.

As part of its program, Tanzania has developed a series of brightly colored posters which are widely distributed around the country. The text is in Swahili and it proclaims pride in "our" national parks, the benefits to posterity of "our" parks and so forth.

In and of themselves, of course, tourists beget problems. More tourists inevitably result in more litter, more carelessly tossed cigarettes. There is the ever-present possibility of injury to tourists who fail to realize that an apparently placid lion or elephant is still potentially dangerous.

More stringent controls on the movement of tourists in the parks appear inevitable. Automobiles will have to be restricted to the main roads and not be permitted, as now, to take off across country, killing grass and causing ruts that turn into gullies when it rains. Already, Kenya is thinking of requiring all visitors to leave their cars at the park entrances, and transfer to sightseeing buses.

There is something melancholy about all this, yet there appears to be no alternative. For now, the survival of these magnificent beasts of the wild appears to hinge upon the drive and ingenuity of East Africa's government leaders, and the speed with which they succeed in their conservation programs in gaining the popular understanding and support of their peoples.

Students at Tanzania's College of African Wildlife learn natural sciences necessary for training as conservation-minded game and park wardens.

A cheetah, speediest of mammals, seems to appreciate fast-moving vehicles and pauses for a moment to look one over at Nairobi National Park, Kenya.

By Bennett Schiff

Some of Man's many faces stare back through the veil of centuries

The American Museum of Natural History opens a birthday present—its dazzling treasures of Mesoamerica in a new setting

The mysteries surrounding the ancient civilizations that flourished in Mexico and Central America are almost as impenetrable to historians as those attendant on the Etruscans. They may very well remain so; for how long, no one can say.

There is virtually no written record to help make coherent that series of complex civilizations, which are comparable in so many ways to those of ancient Egypt, the Middle East, India and Bronze-Age China. What there is in written form—three Mayan codices, written in hieroglyphs on bark paper, that somehow survived the missionary zeal of the Spaniards—has largely resisted the scholar's probe. Fortunately, the physical remains have yielded more readily to the archaeologist's pick.

To "read" the history of that locked-away era, that great stretch of time from 1500 B.C. to the arrival of Cortés in 1519, it is necessary—and rewarding—to look at its creations. Few of the world's great systems of art are at once so edifying and so entertaining.

One of the best places outside Mexico to make this sort of study is New York's American Museum of Natural History, which, as part of its 100th anniversary celebration, has opened an entirely new exhibition hall devoted to the arts and civilizations of Mesoamerica. The Museum has long been attentive to this region and the extraordinary societies that developed there, apparently in complete isolation from the civilizations growing up at the same time in Europe and Asia. As early as 1869, the year of its incorporation, the Museum had acquired a group of objects from the region. And by 1899 it had devoted an exhibition hall to the archaeology and art of Mexico and Central America, which—through successive changes and additions—has now been metamorphosed into a dramatic and radiant chamber.

The permanent collection is a full one, representing all the regions and time sequences of the area. It is outstanding, as well, for the number of rare and notable works it contains. Added to it for the current exhibition are a number of recent acquisitions, never on public display before, along with loans of especial interest.

Reproduced in these pages are works from western Mexico, notably the extraordinary figures from Chupícuara, Colima, Nayarit and Jalisco; these effigies of gods and ordinary mortals are prime examples of expressionistic fervor and technical mastery. The art of sculptural portraiture was highly developed here; there are rich psychological insights, and sometimes irony. A characteristic of part of this work is its strongly Oriental cast; is this a link to the antecedents of these peoples, who are thought to have crossed a land bridge from Asia to Alaska some 15-to-20,000 years ago, or does it reflect, as now seems likely, later migrations across the Pacific?

Recent discoveries indicate that there were attempts to cultivate the soil in Mexico as early as 7000 B.C. Maize was a regular crop in 5000 B.C., and by 1500 B.C. the systematic making of pottery was well estab-

The unusually large size (28½ inches) of this ceramic figure from Nayarit suggests a rare technical mastery. It is of a type known as "Chinesco" because of its Oriental look.

This 6¼-inch figurine in the Chupícuaro style of western Mexico is of a hunchbacked woman (the deformity may have had symbolic significance). It dates from well before the Christian era.

lished. These are truly ancient civilizations. The Olmecs had risen to their full development by 1200 B.C. and were already creating mammoth sculptures in stone and the most elegant small works in jade. There is the mysteriously evocative, decorative and grotesque style of the Teotihuacán civilization, which also built the great pyramids near Mexico City. And look carefully at the fearsome life-sized Toltec ceramic figure of the god Xipe-Tótec, "our lord the flayed one" (page 40). It is as powerfully monolithic as any of the sculptural presences of ancient Egypt. From each of the other regions and peoples represented here—Aztec, Vera Cruz, Maya—there is distinct evidence of the power, fancy and penetration of the art produced by these peoples.

It is natural, in viewing these works, to think of the land from which they derive, a land of volcanoes, fire, water, stone, earth and sun. It is, in this sense, an earthly art; so much of it is of clay, of earth and water fused by fire. Its coloration, too, is of the earth. It is art for a purpose; in short, because it is funerary, or animistic, or religious, it is utilitarian art. But it is pure art as well, existing independently, simply to be looked at.

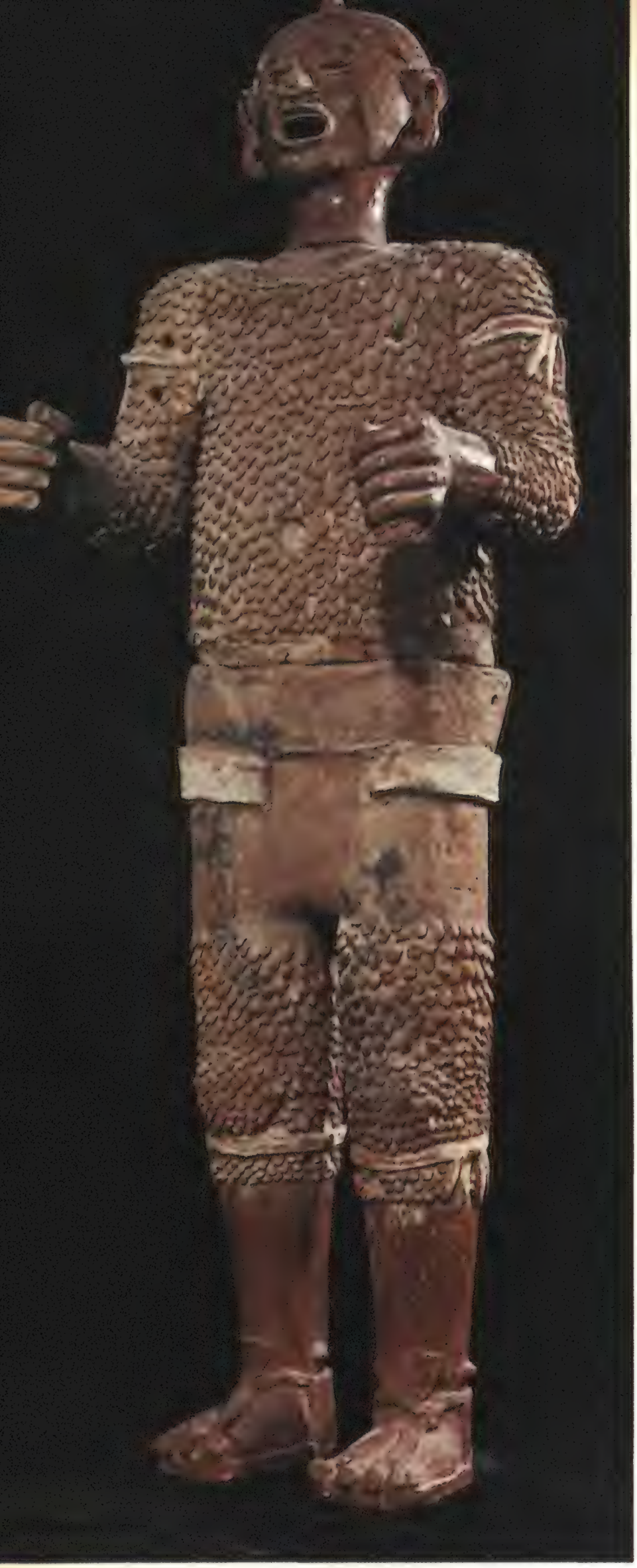
It is art free of the strictures and argument of Western art, where the artist, rather than expressing a common view, sets off to express his own. It is doubtful, therefore, that many of the citizens of these highly developed and at times bloodthirsty societies felt the need or duty to attack the artist for his view of things. His view was their view; he was part of the central current of his place and time.

It is widely variegated art in style and embellishment, reflecting the entirely different qualities of the particular societies it derives from. Nevertheless, there are a number of characteristics, aesthetic and otherwise, that apply to the art of Mesoamerica as a whole. It is certain and direct. There is no hesitation, confusion, quibbling. It combines, with no uneasiness, the fantastic, the hieratic, the decorative and the domestic aspects of the mysterious societies that produced it.

For two years this rich pre-Columbian collection has been homeless and hidden from view while the new hall was in preparation. We welcome its return.

Humanistic realism marks an 11-inch sculpture from Las Remojadas in Vera Cruz. This remarkable piece has a typically portrait-like head and a minimum of costuming detail.

Archaeologists speculate that ceramic masks such as this long-nosed example found in the tombs of Colima were placed on the faces of the dead during burial ceremonies.



A representation of Xipe-Tótec, a rain god, this figure is probably wearing the flayed skin of a sacrificed human victim. This is one of the few man-sized figures from Mesoamerica.

The sole surviving example of Olmec wooden sculpture, this superb mask was found in a cave south of Taxco. It was clearly designed to be worn, and fits nicely on the head.

Only 6½ inches high, this cheerful little man is typical of the simplicity and compactness of the Jalisco style, as are his unusually long face and large eyes.

The abundance of masks found in ancient Mexico and Central America is evidence of their great importance in these vanished cultures. This Aztec mask is of stone.

Harbinger of spring, dandelion blooms early
and secretes copious nectar which delights bees.
The weed is an important source of honey.

By William J. Breisky

My dandelions and yours—a salute to a stubborn plant

Bright, abundant, nutritious, intoxicating, and above all determined, the familiar plague of all our lawns gets an admiring nod

When Emma Stewart and I agreed, in the spring of 1968, to have a vegetable plot cultivated in the field behind her house and mine and to share the plot, neither of us saw fit to draw a dividing line. Mrs. Stewart's reputation as a gardener was widespread, and I was strictly a trial-and-error farmer. I was certain no one would have trouble distinguishing her tidy rows of vegetables from my helter-skelter tangle of scrawny edibles and virile weeds.

Our gardens met at the center of the plot, but because we did our gardening at opposite ends of the day, we had little opportunity to discuss our respective crops. So it happened—as I should have guessed it would—that Mrs. Stewart came one day to our back door, to apologize.

"I'm afraid I've done a terrible thing," she told my wife. "I was pulling some dandelions next to where my yellow squash is starting to come up when I suddenly realized that the dandelions were in rather even rows, and that your husband may actually have *planted* them there."

I had, indeed, planted those dandelions—after having discovered that dandelion greens are more nutritious than their highly touted cousin, spinach, and that it is possible to buy seeds for a cultivated dandelion which is considerably more robust and less bitter than the ordinary lawn variety.

We didn't tell Mrs. Stewart at the time, but I was also fermenting a batch of dandelion wine (made from the flowers of ordinary lawn dandelions) in an old stone crock in the basement, and seeking to remove a wart from my son's left wrist with regular applications of the "milk" squeezed from stems.

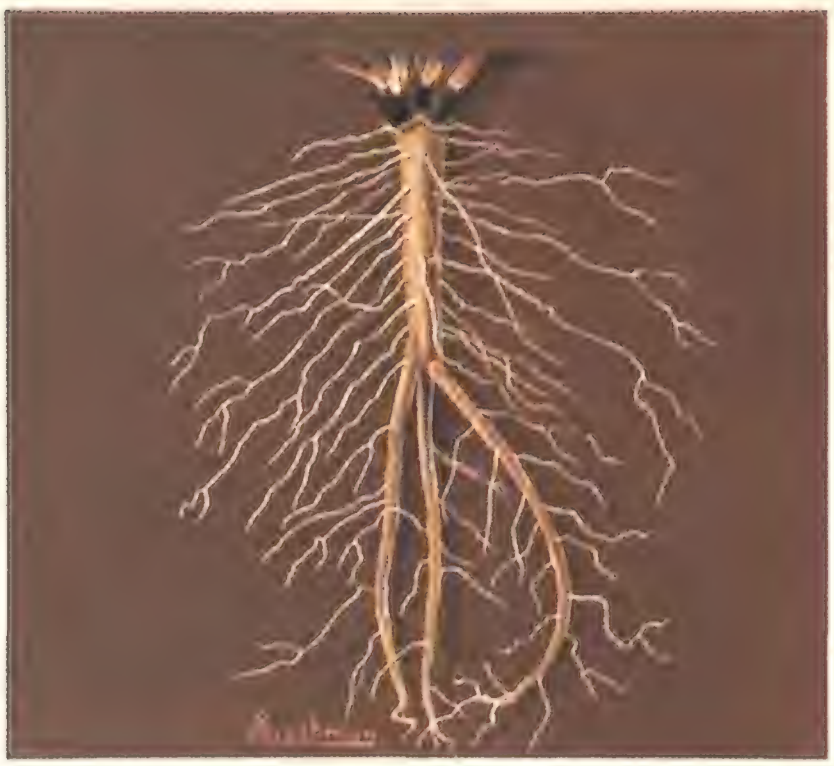
The more I have learned about the common dandelion *(Taraxacum officinale)* the more I have wondered how it came to be classed along with poison ivy, mosquitoes and street riots as one of the noxious aspects of summer. This versatile plant may be described as wild flower, medicinal herb, salad green or weed, depending on your prejudices. As a matter of fact, according to Ralph Waldo Emerson's definition of a weed—"a plant whose virtues have not yet been discovered"—the dandelion is no weed at all. Its every component, from root to blossom, has been revealed as not only virtuous but profitable.

Wonderfully versatile roots

The carrotlike roots are perhaps the dandelion's most versatile part. In powder or liquid-extract form the roots are known to pharmacists as taraxacum. The root of an exotic dandelion species known as *Taraxacum kok-saghyz* discovered high in Russia's Tien Shan Mountains near the Chinese border, was found to yield an excellent quality of latex. Our Department of Agriculture grew several hundred acres of *kok-saghyz* during World War II and found its latex expensive but "highly satisfactory" for heavy-duty tires. The experiment ended when satisfactory forms of synthetic rubber were developed.

In several European countries—and in Gypsy camps around the world—dandelion roots are dried

A former assistant editor of Saturday Evening Post, *the author now manages the Bermuda News Bureau, raises bananas as well as dandelions, and voyages in a rubber boat ("We have the dinghy, not the yacht").*



Sturdy, deep-probing taproot usually defies dandelion-haters: Snapped off, it grows afresh. Roasted roots serve as dubious ersatz coffee.

and roasted to be blended with coffee or hot chocolate. My wife and I have sampled Roasted Dandelion Beverage, a caffeine-free coffee substitute once imported by a Kentucky firm from Scotland to American health-food stores. We remain partial to plain old-fashioned coffee. But if you're looking for a healthful substitute for the coffee bean, you might consider dandelion root.

The dandelion's leaves are tossed in salads, cooked as a potherb and dried for steeping in teapots. Middle Eastern silkworms find them an acceptable substitute for mulberry leaves—and I'm told that my step-grandmother's father, in the German seacoast town of Husum, used to feed them to his rabbits to safeguard against liver ailments. The dandelion's stem is a versatile toy which can be fashioned into necklaces of green loops or used to blow soap bubbles. Its milk serves as a folk remedy for warts. A 1916 herbal published in London tells us to "squeeze the broken stem. A drop of milky juice will come out. Touch the wart with that and leave it on to dry." The treatment is alleged to be most effective in the summer. My six-year-old son's warts have not responded to it.

"Milk" is by no means the most potent liquid the dandelion can produce. Bees prize the blossoms as a source of honey, especially in the early spring. Those same blossoms, blended with sugar, lemons, oranges, yeast and sometimes raisins, make a delightful and potent cup of cheer which is known in Iowa as Keokuk Wine and in Vermont as Dandelion Blow. A writer for a New Zealand health magazine once claimed that dandelion wine could be used "instead of sleep tablets."

The dandelion "puff"—the matured, white-haired blossom—has been embalmed in plastic for use as paperweights.

The dandelion is said to have been one of the "bitter herbs" of Passover, eaten by ancient Israelites to purge themselves of wickedness. In centuries past, a heady ale was brewed from its leaves and flowers by the peasantry of many countries.

Most botanists believe the dandelion immigrated to the United States from Europe. Some say Greece was its birthplace. Others claim that the name, *Taraxacum,* derives from the Persian *tarkhashgun,* a wild endive. The derivation is more commonly believed to be from the Greek *taraxos* meaning disorder and *akos* meaning remedy, thus attesting to the ancient use of its medicinal properties. All agree that it now resides happily throughout most of the world, and recent studies by the U.S. Department of Agriculture indicate that scientists are conducting research on dandelions from Afghanistan to Finland and from Switzerland to the South Pacific.

Our word dandelion derives from the French *dent-de-lion,* or "lion's tooth," alluding to the plant's jagged leaves and perhaps to its golden crown. Among the more earthy French cooks, the dandelion is known as *pissenlit,* referring to its alleged diuretic properties. Other nationalities follow the custom of likening the plant to a lion's tooth. Germans call it *löwenzahn;* there was a *danty llew* in Wales as early as the 13th century; and in ancient Rome it was *dens leonis.* It is also called Swine's Snout, Yellow Gowan, Irish Daisy, Blowball, Peasant's Cloak. A medieval name, Priest's Crown, referred to the green and eager bud which grows up to resemble a

golden-haired seminarian, and later matures into a distinguished pastor whose hair turns white and finally falls out.

Robert Seymour Bridges, the physician who became Britain's poet laureate more than half a century ago, admired the "shock-haired dandelion, that drank the fire of the sun." In 1845, the American poet James Russell Lowell wrote admiringly of the "Dear common flower, that grow'st beside the way, / Fringing the dusty road with harmless gold."

American Indians appreciate the dandelion as food. Former Indian Affairs Commissioner Robert L. Bennett, an Oneida, recalls that he and others of his tribe hunted and ate dandelion greens when spring came to Wisconsin.

Betty Furness, who claims to be "an admirer of how they look on someone else's lawn," gave me my favorite recipe for dandelion salad. She recommends tossing the greens with a bubbling-hot sauce made of melted butter, thick cream, eggs, spices, bacon and bacon drippings. And when Gene Leone was running his family's famed New York City restaurant, he used to say his favorite luncheon consisted of a bowl of his "Spring Dandelion Salad" (dandelion greens, eggs, cooked meat, cubes of Italian bread, tomatoes, melted butter, oil and vinegar, spices) served with a Bel Paese, stracchino or fresh mozzarella cheese and a bottle of Bardolino.

Most Frenchmen like their dandelion greens "the classic way"—as a salad with a fine French dressing, or as a potherb "cooked as you would spinach." Many Canadians prefer buttermilk dressing over their greens. The Greeks call the dandelion *agrio radiki* ("wild greens") and serve it as a salad, boiled in water and dressed liberally with olive oil and lemon, in a lamb casserole or as the base for a hot drink. The Pennsylvania Germans prize dandelion greens as *bidderer selaat* ("bitter salad"), and traditionally serve them on *Griener Dunerschdaag* ("Green Thursday") of Holy Week. The custom is supposed to assure good health throughout the year.

Exactly what health-giving properties the dandelion contains is subject to dispute. Nutritionally the greens are superior. They yield as much iron and vitamin A as any vegetable and are rich in mineral salts. Medically the dandelion still has a reputation. Herbalists as recently as the turn of the century touted it to those seeking treatment for everything from sluggish liver, ague and dropsy to "palpitations of the heart" and "wounds of every description." In 1871, a British Army lieutenant reported to the Agri-horticultural Society of India that "I know several gentlemen in India who are kept alive by the daily use of taraxacum coffee. It is fairly entitled to be called a specific for the cure of torpid liver, a complaint from which the majority of Europeans suffer." Dandelion root may still be found on some pharmacists' shelves. But one pharmacist friend, whose medications have rescued me from various ailments and who graciously shared his dandelion wine secrets with me, reports "no call for it in 11 or 12 years."

They grow in Brazil, too

Therapeutic or not, *Taraxacum officinale* continues to be cultivated by gardeners who would add vigor and spice to their diets. Botanist Howard Irwin, curator of the herbarium at the New York Botanical Garden, told me he has seen cultivated dandelions as far south as the interior state of Minas Gerais, Brazil, where they are grown in discarded oil drums, "among other plants which collectively would be called a kitchen garden."

The first known American cultivator of dandelions was a Brookline, Massachusetts, farmer who grew dandelions for the Boston market 150 years ago. It was on a farm in Windsor, Connecticut, just north of Hartford, that I was first introduced to the risky business of cultivating dandelion greens commercially. Before he gave up his business two years ago, Nelson Christensen, a solid, husky-voiced man and third-generation dandelion grower, had said the demand wasn't what it used to be. At that time he

Ripe for the salad bowl, tender leaves guard
springtime's first bud. Cooked greens
soothe the liver; dried, they make a mild beer.

Salute to a stubborn plant

seeded his dandelion beds in May, ignored the late-summer leafage ("too bitter") and harvested the greens early the following spring.

Christensen's cousins Dan and Ken still operate the adjacent North Meadows Farm, where they get a 1,000-bushel yield of tender, 18-inch greens from an acre of dandelion beds. Dandelions, says Dan, with a straight face, are "hard to weed." He and his brother continue to cultivate them only because they have invested in cold frames. You need these if you want to get your greens to the wholesaler early, when you can command four dollars a bushel.

Nelson Christensen says his wife cooks dandelion greens "like spinach, with butter, salt and pepper." Dan Christensen says his wife almost never prepares them. "I'll eat them," he declares, "but she won't clean them."

Dandelion greens are tastiest if cut before the plants begin to flower. Perfectionists boil or sauté the outside leaves, saving the tender, inside leaves for salad. To make all the leaves more tender, some growers blanch plants, by covering them with sand or with two boards set lengthwise, or by growing potted dandelions in a warm, dark cellar.

If cultivating dandelions is a difficult task, eradicating them is a herculean one. An indirect approach is as good as any: By fertilizing your lawn heavily, you may succeed in getting the grass to choke out the dandelion. Carbolic acid has been used as a dandelion killer. A garden tool resembling a skinny chisel and known as a weeding spud is probably the most popular—and least effective—anti-dandelion agent. It may be useful for harvesting a mess of greens for the salad bowl, but your chances of getting an entire root with a spud are slim, unless the ground is very wet. And as my wife and I—and many a veteran gardener—have discovered, an excellent way to encourage the growth of a double dandelion is to pull up half a dandelion root.

This capacity for self-preservation is one of the dandelion's most amazing qualities. Its taproot grows deep, out of range of rabbits and drought. The leaves of the uncultivated dandelion lie almost flat, rosette-style, where there is maximum moisture and carbon dioxide, and where lawn mowers can't reach them. Each blossom is in reality a bouquet of as many as 200 flowers, which have the good sense to get under cover on rainy days, to keep both the nectar and pollen dry.

After the flowers' pollination period, the bracts close up temporarily and the stem lies low. Finally the stem stands erect once again and the bracts reopen to reveal some 200 matured seeds, each one attached to a hairy parachute which can transport it over great distances. I suspect it was an airborne seed which introduced the wild dandelion to our present lawn, almost 700 miles at sea, in Somerset on the island of Bermuda.

Honeybee not needed

The honeybee's visit to the dandelion is superfluous. The prolific plant forms its seeds before its flower head opens.

The late author-naturalist Neltje Blanchan (Mrs. Frank Nelson Doubleday) was surely a most eloquent dandelion admirer. "How," she once asked of this indomitable vagabond, "has it managed without navies and armies—for it is no imperialist—to land its peaceful legions on every part of the civilized world and take possession of the soil? How can this neglected wayside weed triumph over the most gorgeous hothouse individual on which the horticulturist expends all the science at his command?"

Surely we have much to learn from a conqueror who is systematically stabbed and poisoned, only to vanquish his tormentors and offer them a golden bouquet, plus more than 30,000 units of vitamin A per cupful of raw leaves.

Mrs. Stewart, in time, has come to respect my cultivated dandelions growing alongside her yellow squash. And my father-in-law, at first bemused by my experiments in fermentation, now caches my gift of homemade dandelion wine in his basement—in order, he says, to avoid having to share this precious gold with his thirsty visitors.

Shut your eyes and blow on the puff. If no seeds
remain you'll get your wish—and your neighbor
downwind will get a dandelion crop in the spring.

INTERNATIONAL PAPER ANNOUNCES A $101 MILLION, FOUR-YEAR PLAN TO COMBAT POLLUTION.

International Paper Company believes that the aspirations of our society for a better life can be met, that the pollution of our environment can be controlled, and that the vital quality of the basic resources we all share can be maintained within the framework of our economy. International Paper is dedicated to do its part as an industrial citizen to achieve these goals.

I can now report to you that the Company has adopted a four-year plan, to be completed by 1974. This plan places International Paper in the forefront of those taking positive, constructive measures to solve the problem of environmental quality.

We estimate the total cost of this program will be $101 million.

When this program is completed every one of our U.S. pulp and paper mills will be equipped with primary and secondary waste water treatment systems.

Water so treated does not adversely affect the complicated life chain in natural waters—from bacteria to plankton, to plants and fish life.

In terms of air quality this program will utilize the latest technology, which will permit us to remove over 99% of particulate matter from mill emission points. Presently installed equipment has an efficiency factor of about 90%. It will also include adaptation of new technical developments that will control the odors of a kraft paper mill.

International Paper pledges to apply its technology, its resources, and the efforts of its people to this end.

EDWARD B. HINMAN
President, International Paper Company

The art and sport of boomeranging

Washington, D.C., law steps politely aside as Smithsonian Associates take over the Mall for some Australian aboriginal fun

District of Columbia law is explicit on the subject: "It shall not be lawful for any person . . . to throw any stone or other missile in any . . . open space, or public square, or enclosure. . . ." That was why three Smithsonian, two District of Columbia and two National Park Service representatives met in the middle of Washington's Mall. The Smithsonian Associates proposed to hold a series of workshops for adults and youngsters in the making and throwing of returning boomerangs—missiles, that is. And the site was to be the Washington Monument grounds, right in the heart of the District. The police and Park Service regarded the request with misgivings.

There were a few warm-up throws. The looks were dour. Then Susan Hamilton, director of the Associates, began tossing. She throws well and looks even better. Interest flickered across the faces of the officials. They decided to give it a try. The senior official present managed to bring his boomerang back to land at his feet. Broad grins appeared. Permission granted.

The boomerang, that strange Australian aboriginal tool and plaything, had worked its magic again. A curved stick of wood, flat on one side and rounded on the other with a twist on the ends, it returns to its thrower after a circular swooping flight curiously like a bird's. People seeing a high-performance boomerang flying for the first time sometimes actually clap their hands for joy, the effect is so charming.

Each workshop session ran four hours, two hours indoors in the National Museum of History and Tech-

Benjamin Ruhe, who ran the workshop, shows how to catch a returning boomerang safely. He worked in Australia as "the only Pennsylvania-Dutch jackeroo."

Cricky Bryant, age eight, barely avoids a haircut from a fast-whirling returner. Boomerangs lose forward speed at flight's end, but keep spinning.

No, it didn't go around the Washington Monument, but a strong-armed expert could do the trick. Hurling a boomerang around a post is a common stunt.

Participants were given plywood blanks to carve into boomerangs. Australian aborigines developed the proper pitch and foil through the ages.

nology and two outdoors on the Monument grounds. The boomerangs were small and light to insure safety, although most boomerangs are probably less dangerous than a baseball.

To start off the workshop there were two remarkable ethnological films from Australia, showing aborigines crafting boomerangs with Stone-Age techniques that are excruciatingly tedious. Because boomerangs are interestingly shaped and often made of beautiful woods such as silky oak, rosewood and mulga, there is an aesthetic pleasure in examining them. Accordingly they were handed out—big ones with 28-inch wingspans, little ones, plastic and plywood ones. On display were boomerangs from the Smithsonian's National Air and Space Museum, collected at the turn of the century by Secretary Samuel Langley, a pioneer in the theory of flight.

How to throw a boomerang

A lecture covered history (the evolution of the boomerang is completely unknown, but it probably evolved from the flattened, slightly curved killer stick still used in Australia). It discussed aerodynamics (the boomerang, in a wildly simplified explanation, is like a gyroscope acted upon by aerodynamic forces that make it curve to the left until it returns to a right-handed thrower). It told how to throw (vertically, with a sharp whipcracking motion, and aimed at the horizon); where to throw (away from people, far, far away); when to throw (when there is little or no wind); in what direction (to the right of the wind—left-handers use a mirror image boomerang and throw to the left of the wind); and what not to do (throwing should not be overdone on the very first day or else the thrower might not be able to lift his arm on the second).

At the end of its flight a boomerang has lost all forward impetus but is still spinning rapidly. It will hover in the vicinity of the thrower and can be caught. The trick is to trap it between outstretched palms, with fingers well away.

The variety of contests that can be held suggest the range of skills to be developed. In distance throwing, the boomerang is thrown as far out as possible but must return to the point of origin. The record is about 100 yards, the length of a football field. The opposite type of test is short-throwing. Contestants face a wall and let fly. If a boomerang hits the wall the thrower is out. Survivors advance closer and throw again. Finally there is one person left. In accuracy tossing, the boomerang is thrown around a post and brought precisely back. A fourth competition is catching; one Australian has scored 49 catches in a row. Continuous throwing calls for the use of two boomerangs: The object is to maintain one in the air at all times, and the winner is

the man who continues this "juggling" for the greatest number of throws.

For the second part of the workshop, the class adjourned to the Monument grounds for a picnic under the trees. A demonstration of throwing followed, then there was general throwing, carefully monitored by a corps of volunteers. Each adult-youngster team had been provided with an Australian returner. And in addition, each person received a precut blank of aircraft plywood, along with instructions on how to carve it on the spot into a flyable boomerang. Finally, there was a competition for two handsome trophies donated by QANTAS, the Australian airline.

Three youngsters brought their boomerangs back to hit within the three-yard throwing circle during the course of the four sessions. In a playoff, after the last workshop, Alfred Shapiro, 10, of Chevy Chase, Maryland, scored the lowest total yardage to gain the individual trophy. John T. Smith, commercial minister of the Australian Embassy, made the trophy presentation and then, doffing his coat, proceeded to take a lesson in the art.

Australian tourists gape

As might be expected, boomerang throwing in the center of the nation's capital stirred widespread interest. Newspaper reporters waxed poetic. A radio interviewer suggested that a boomerang might be an appropriate gift for that far from anonymous government official who earlier in the year had hit one partner with a golf ball and another with a tennis ball. On the Monument grounds, Australian tourists gaped at the sight. Some had never before seen a boomerang thrown. A leggy young mother in a miniskirt broke her boomerang by heaving it straight at her feet. Her eight-year-old son on the sidelines complained: "I don't see why my mother has to break a boomerang and nobody else did." She then redeemed herself with unusually expert tosses. One father with son and daughter watching brought his boomerang exactly back into the three-yard throwing ring. "They'll have to listen to me now," he said, as he walked off trailed by his children.

Predictably the boomerangs elicited strong interest at the Smithsonian itself. Secretary S. Dillon Ripley requested a lesson. From across the country professors of physics and ethnology wrote asking for information. A toy manufacturer sent an unsolicited gift of plastic contraptions. He concluded his letter: "Many happy returns." And Henry Wallace's widow promised to search her attic for one of the boomerangs her late husband once threw out on the Mall when he was Secretary of Agriculture, for inclusion in the Smithsonian collection.

Mrs. Gerald Kinzelman carries boomerang blanks for her son in her belt—aboriginal-style. A total of 179 people participated in the program.

The winner and champion, Alfred Shapiro, age ten, shows off his trophy. He threw the best returns—they landed the shortest distance from where he stood.

By Robert Evett
Color photographs by Lee Boltin

Restoring to antique instruments their looks—and their voices

Museum pieces that actually work: Robert Sheldon plays an 18th-century flute from the Smithsonian collection, while James Weaver accompanies him on the Stehlin harpsichord (1760) shown opposite.

Much of our music was written for instruments no longer in use, but at the Smithsonian you can hear how it sounded to the composer

You would think it would be perfectly obvious that a musical instrument is something that produces sound, and that unless an artifact meets this requirement, it is not really a musical instrument, but something else: an example of cabinetmaking, a curious-looking object. However, most of the antique instruments in the great collections are mute. Whether they are kept in glass cases or behind ropes, whether they are flutes looted from Egyptian tombs or old pianos left as legacies to museums, they have one trait in common: they are Out of Order.

There are not many first-class collections of instruments in this country or in the world. In the United States, the collections of the Smithsonian Institution, the Metropolitan Museum of Art, the Boston Museum of Fine Arts, Yale University and the University of Michigan are recognized as the big ones. But most of them have very few instruments in playing condition. The Metropolitan has been for years, and still is, a tomb for these old contraptions, some of them interesting and some not. Presumably, they will continue to languish until a projected new wing is built with adequate space for displaying and caring for them.

Since 1958, the Smithsonian has set an example to the world in its practice of giving the instruments their voices back. In Washington, at the Museum of History and Technology, the Smithsonian employs a staff of seven—the largest of its kind in the country—to provide curatorial services and to do the work of restoring some of the instruments.

At the Smithsonian a problem is posed just by the size of the collection, which has been growing for more than 90 years. By the time the work of restoration was begun, the Museum owned more than 4,000 musical relics, and even if there were now some object in putting them all back in shape, there wouldn't be enough money or personnel to do it. In consequence, a good deal of thought goes into which instruments are to be sent to Elizabeth Arden's, so to speak, for "the works."

There is, for instance, a late 19th-century harp piano. This machine looks something like a modern apartment spinet, except that jutting up from the back of it is the upper part of the wing of a harp. The Museum owns a photograph of an old party with a walrus mustache playing it (right). Musicologists specializing in Americana might like to know how this fanciful invention sounds and how its action feels; but it is so eccentric an offshoot from traditional piano-building that there would be little justification in taking on the expense of reconditioning it.

This is one of the many instruments in the collection that has the advantage of being both funny looking and relatively rare. However, in terms of the restoration program, neither of these traits is an advantage at present. Instruments are selected for resurrection not on the basis of their oddity but rather because of the relevance they have to music within the context of some tradition. This may be, and very often is, art music. But not necessarily. The Smithsonian owns a great many of the instruments used in making folk music, and has taken American banjos and dulcimers—some of them homemade and not really old—and put them back in shape. And there are instruments associated mostly with popular music. For instance, the Museum owns Hammond Organ No. 1, as well as music boxes and automatic devices that were familiar to city slickers a hundred years ago.

It was rumored that the Smithsonian also was thinking of acquiring a theater organ, by which is meant one that was used in movie houses in the '20s and '30s. It is interesting to speculate as to why a pipe organ was considered to be an essential part of the entertainment in those days, but I remember being fascinated as a child by one of these things which, when you pushed a button, would go off into a cascade of percussion effects, had a harp stop, and, through some alchemical magic, would keep playing by itself when the organist got up from the console and began to accompany himself at the piano. Grisly? Yes. But there were thousands of these instruments, and they are disappearing as fast as the old theaters are being torn down. A typical one is just as much a part of our cultural heritage as are the movies of the same period, and if one in working condition is to be preserved, the place to preserve it would be a great museum. But unfortunately few museums—and certainly not the Smithsonian—have the space to install anything so monstrous in size.

A large part of the Smithsonian collection—and

If they laughed when he sat down at the piano—well, it was a funny-looking piano. Hugo Worch plays an invention of Kuhn & Ridgeway, Baltimore, c. 1857.

Robert Evett is a music critic, a former editor, and a composer. His Harpsichord Sonata has just been issued on the Composers Recordings (CRI) label.

The lute dominated European music during the late Middle Ages and the Renaissance. This example was made by Uldrich Dieffopruchar in Venice, 1521.

The curved *oboe da caccia* is an 18th-century version of today's English horn. Slightly later in date is the flute with seven tuning joints to change the key.

one in especially heavy demand right now—is the collection of old keyboard instruments: harpsichords, clavichords, pianos and organs.

The oldest of them—those going back to the 17th and 18th centuries—can be extremely temperamental, even when restored. The principal reason for this is that most of them, ever since they were made, have been subjected continuously to fluctuations of humidity and temperature that are disastrous to wood, ivory, and the other organic substances that went into their manufacture. Then, too, taut strings exert a terrible pressure on a wooden frame. Even if the instrument is a violin and there are only four strings pulling at the wood, the wood itself is under heavy pressure. Of course, the frame of a harpsichord or piano is heavier than that of a fiddle, but the pressure of the many strings—183 of them for a good-sized harpsichord—is obviously much greater. Anybody who owns a piano knows very well that unless it is exercised regularly it goes out of whack. How much worse, then, for an instrument that has been sitting around in an attic for years!

If you look at an unrestored 18th-century piano, your first impulse would be to give it up entirely as a hopeless job. The strings will, of course, have rusted; the sounding board may be cracked in 50 places; the keys will be bent out of shape like arthritic fingers; bits and pieces of the instrument will have fallen off. Obviously, the work of putting it back in shape will be time-consuming and costly. As a consequence, the instruments usually chosen for restoration are those that, in the opinion of the staff, represent the most typical examples of significant types. One of the first instruments restored at the Smithsonian, for instance, was a Schmitt piano dated Salzburg, 1788. It was chosen partly because it is such a lovely thing, even though the curators were aware that it might not be in every way the best example at hand of the so-called "Mozart" or "Viennese" piano, the instrument so different in so many ways from modern pianos, yet the one for which the Mozart concertos and the early Beethoven sonatas were written.

If an instrument *is* "restorable," there is a big question as to what can be saved and what cannot. Though the art of restoration is by no means in its infancy, there are problems that cannot be solved by existing techniques. Hopelessly warped pieces of wood, for instance, have to be replaced. The same thing is true of old varnish. According to an apocryphal story, there was some trouble a few years ago over an 18th-century chamber organ in the collection. It had been fixed up and sounded fine, but it looked terrible. Somebody said, "Let's put on a coat of varnish." Scott Odell, the man responsible for the work, recoiled in horror. He pointed out that, in 30 or 40 years, there would be new techniques of restoration and that the technicians of that day might be able to bring the original varnish back to its original condition.

The rule in restoration is to keep everything that can be saved, and to replace what can't with material as nearly identical as possible to that used by the original builders. Thus, in repairing a Stehlin harpsichord

dated 1760 (shown on page 53) the sounding board—cracked in 50 places—was patched with tiny slivers of the kind of wood Stehlin himself had used. And, on this instrument, even the glues were duplicates of 18th-century glues.

The one glaring inconsistency in this is the use of a material called Delrin plastic on the business end of the harpsichord jacks. In the old days, people used crow quills. At the Smithsonian, they got themselves some crows and experimented. How they got the crows to part with the quills is not a matter of public record. The important thing is that the experiment did not work; the crow quills broke too frequently to keep the instrument in playing condition for public performances. Hence the Delrin. If the restoration techniques of the future make it possible to use real quills, the instruments will still be there. Until then Delrin will have to do. It is a most satisfactory compromise, but a compromise nonetheless.

The Smithsonian collection is weakest in violins from the baroque period. This is not altogether surprising, because if there is one old instrument in current use, it is the violin. The most highly prized specimens in the world are, of course, those made in Cremona in the late 17th and early 18th centuries by Amati, Guarneri, Stradivari and others. At going rates—and they are going up all the time—many of these instruments sell for $30,000 and more, and a museum curator would be out of his mind to buy one.

And what would he do with one if he got it? A fact

The ungainly instrument in the foreground is a 12-keyed basset horn (tenor clarinet) by Griessling and Schlott of Berlin. Behind it, at left, stands a "piccolo" trumpet by Leopold Uhlmann of Vienna and, at right, a keyed bugle made by Graves and Company of Winchester, N.H. All are 19th-century.

This beautiful orchestral horn was made in Paris by D. Jahn about 1825. It has been superseded by the French horn with valves that we know today.

The aptly named serpent would sound the same if it were perfectly straight; the curves are simply to make it more compact. Made in London, 1805-07.

that is readily available but not widely known is that these great old instruments were, almost without exception, rebuilt in the early 19th century, so that the necks were attached at a more acute angle than they had been originally and the bridges were raised. At present, too, they are strung with wire instead of with gut, as they were originally. The result is a far more brilliant sound than could have been produced by a Strad in its original condition. But would a museum be wise to "baroque" one of these fiddles—break the neck and put it back where it once was, and so on? Certainly right now this would raise an outcry (although performers who specialize in old music have had lesser instruments baroqued for them).

As a general rule, the instruments that cause the least trouble, in terms of upkeep and care, are those with the fewest moving parts. There are some beautiful old wind and brass instruments in the collection that are sturdy and would be quite serviceable if anybody wanted to play them. The trouble is that so few people can, or could, play them proficiently. One of the most beautiful—in appearance, at any rate—is a horn (directly above) dating from the time of Schubert, with a magnificent set of crooks, allowing the player to perform in eight different major keys. But who wants it? On a modern horn with valves you can play in any key you please, or in none at all if that is indicated, simply by fingering correctly. Changing the crooks on a horn is not quite as tedious as changing a tire, but it is a time-consuming job. The technical changes in wind-instrument manufacture in the 19th century were more than just changes: they were real improvements, and they were so extensive that a modern player—even a first-class virtuoso—has an ungodly amount of trouble adjusting his technique to the old instruments. Thus, at an exhibition concert in the Smithsonian in the fall of 1969, a trumpeter gave quite a dazzling show on a pair of baroque trumpets—but, having earned his supper, played the rest of his program on modern instruments with valves.

"Please do not touch"—for good reason

It would be a pleasure to report that the result of all this labor is a collection of instruments invitingly placed so that anybody who wants to have the thrill of playing an 18th-century harpsichord or piano can do so. The fact is that it is extremely difficult to get your hands on any part of the collection, or even to see it, since only a minuscule part of it is on exhibition at any time. On the fourth floor of the Museum there is a room in which the temperature and humidity vary almost not at all. There these tetchy old contraptions lie, quiet but in operating condition.

However—and this is the distinguishing feature of the Smithsonian collection—they are played, and played constantly, in public recitals and concerts. Some of them are extremely fragile and can be moved safely only for very short distances. And some of the hardier ones are actually on view.

The evening concert series—monthly during the year—has become one of the most engaging events in

Washington's musical life. The programs are well planned and free to the public and the players are good. Presumably, most of the people who attend are looking for good music and take only a secondary interest in the collection.

But for the serious student there are things to be learned here that are not otherwise available. For a very practical example, there is the matter of baroque ensemble music. Anyone interested in playing this music will be struck first by the fact that the 17th- and 18th-century harpsichords are extremely resonant, and make more sound than most modern harpsichords. Second, that old flutes and fiddles are much softer, more delicate, than the concert instruments in current use. That the instruments are not replicas but the actual ones on which the music of the period was played means that they form an indisputable guide for authenticity of style in the matter of balance among instruments. For performers interested in doing it right, or even those who would rather do it their own way, it is immensely valuable to know for sure how baroque music sounded to the people who originally wrote and performed it.

Again, there are problems in the piano music of Beethoven that are baffling to most conscientious performers. There are pedal indications in some of the sonatas that simply don't make any sense on modern concert instruments. The one Viennese piano that is functioning at the Smithsonian is not all that much help, since it is more delicate than the pianos Beethoven preferred; nevertheless, it is the kind of piano that Beethoven would have used as a young man, and the answers to a great many questions can be found in the way it works.

New projects for the old instruments

For most purposes, the replica of an instrument would do quite as well as the real article. Most performing groups devoted to old music—the New York Pro Musica, for instance, or the Syntagma Musicum Amsterdam—make do with 20th-century instruments, and very nicely, too. People who care deeply what kind of varnish is used on an organ case, what kind of glue went into repairing a *viola da gamba,* or whether a harpsichord's plectra are made out of crowquill or Delrin plastic, cannot be very numerous.

There was talk a few years ago about taking the instruments on tour. This idea was given up as impractical and dangerous. For the foreseeable future, the instruments will stay right where they are. However, you will be able to hear them, no matter where you are. The instruments are being used for recordings, which will be distributed in part by the Smithsonian Institution Press, and the first record—the eight violin sonatas of Bach, with the violinist Sonya Monosoff, the harpsichordist James Weaver, and Judith Davidoff, *viola da gamba*—is ready to go.

John Fesperman, the curator of the collection, wants to expand the repertory to include new pieces written for the instruments. For harpsichords and stringed instruments he should have no trouble. But will contemporary composers be willing to learn how to write for old wind and brass instruments, so much more cumbersome than their modern equivalents? At the moment, the question is academic, since there isn't any money at hand for commissioning new pieces. Still, this is a fascinating long-range project, and an example of the enterprise of the Smithsonian's Division of Musical Instruments.

This noble old instrument is a bass *viola da gamba* by Barak Norman of London. The finely carved head on the peg-box is shown in detail on the cover.

When you've really arrived you don't have to shout about it.

Johnnie Walker
BLACK LABEL SCOTCH
12 YEARS OLD

ABOUT $10 A FIFTH. PRICES MAY VARY ACCORDING TO STATE AND LOCAL TAXES. 12 YEAR OLD BLENDED SCOTCH WHISKY. 86.8 PROOF.
BOTTLED IN SCOTLAND. IMPORTED BY SOMERSET IMPORTERS, LTD., N.Y., N.Y.

Book reviews

Dictionary of Scientific Biography
Charles C. Gillispie, editor
(Scribner's, volumes I and II, $35 each)

Among the recent arrivals from the press are the first two volumes in a new venture in encyclopedic publishing. They augur well for the rest of the project. For the first time, the historian of science is provided with a scholarly and authoritative biographical source in his subject field, which is as attractive as it is practical in its presentation.

This project is under the auspices of the American Council of Learned Societies. It has the financial support of the National Science Foundation, and an editorial board of nine scholars in a number of fields to assist the capable general editor, Professor Charles C. Gillispie, professor of the History of Science at Princeton, and Scribner's managing editor, Marshall De Bruhl.

The Dictionary was launched in 1965 after considerable planning. Because of the expense of the work, authors' fees and editorial costs are paid by the Foundation grant while the publisher undertakes the production costs. The two volumes just published are the first of a series of 13 to be issued over the next five years. The Dictionary is deliberately modeled upon the *Dictionary of American Biography* and the *Dictionary of National Biography,* the classic reference works for students and scholars in American history. It is designed to fulfill the same purpose in the field of the history of science. Following the same format, the volumes which have just appeared are expensively produced in clearly legible type on fine paper, with rugged reinforced bindings.

The format of the individual biographies deserves comment, for it was carefully designed to provide for each entry the best available information on the subject with a bibliography that includes original work as well as the prime secondary literature. Personal biography is reduced to the minimum, while emphasis is placed on the scientific accomplishments of the individual.

This project is primarily concerned with astronomy, biology, chemistry, the earth sciences, mathematics and physics. The behavioral and social sciences and philosophy, as well as technology and medicine, come in for consideration only as they relate to the work of individuals concerned with mathematics and the sciences of nature.

The editors encountered several major problems in the planning of this work, which they appear to have solved satisfactorily. It is not a simple matter to present adequately the sciences of the Orient, for they have received relatively little study by Western scholars. Consequently, the editors have had to be satisfied with a limited number of articles that illustrate specific aspects of these sciences, leaving comprehensive consideration of them for future scholars.

The Dictionary will probably take a decade to complete from start to finish and represents an investment of more than a half million dollars. It will utilize the specialized knowledge of more than a thousand scholars selected from more than 60 countries, to produce nearly 5,000 biographies of scientists from the dawn of antiquity to modern times in all parts of the world. One most desirable feature, as evidenced in the volumes just published, is the effort to present in the biographies the most up-to-date original research. In many instances we find here the first study to appear in print about some individual. The 13th and final volume will consist of a detailed comprehensive index.

On the basis of the thoroughness with which the project has been launched, it is conceivable that the finished project may become even more extensive than originally planned. Like its well-known counterparts, it may require supplementary volumes from time to time to keep it up-to-date. No biographies of scientists now living are included, and very few important figures in the sciences who have died since the project was begun will be added.

Thus far, the Dictionary has lived up to its promise—the first two volumes are a delight for the student and scholar alike. It is to be regretted that an undertaking of this scope must be limited to distribution primarily as a library resource, since the cost at $35 per volume will make it prohibitive for many.

—*Silvio A. Bedini*
Smithsonian Institution

Population, Resources, Environment
Paul R. Ehrlich and Anne H. Ehrlich
(W. H. Freeman, $8.95)

This book surely aims to be the ultimate work on the ills of our world. It ranges through history, the future, and the solar system, biology, chemistry, demography, economics, politics, and yet—because the authors really want action—finds space for a complete manual on birth control. It is written for laymen by experts, who think "no biologist has made a greater contribution to mankind in this century than Rachel Carson" when she addressed *Silent Spring* to the general public. The Ehrlichs' book is too tightly crammed with thought and information to be digested easily, but it is free of jargon and richly rewards persistence.

At present rates, they show, the world's population will almost double by the year 2000 and in 3000 there would, at the same rate, be 1,700 people to every square *yard* of surface, land or sea. Already one billion endure unceasing privation, and water and food resources are dwindling.

"All flesh is grass," but the earth's virgin lands will not, the Ehrlichs contend, prove fertile, and the sea is already polluted and overexploited by competing fishing nations who if they were chicken farmers would apparently "eat up all the feed, all the eggs, all the chicks, and all the chickens simultaneously, while burning down the henhouses to keep themselves warm." To send excess population to other planets would mean launching 2,000 100-seater spaceships a day forever, but we don't even have the vehicles to transport millions across earth's own seas.

The Ehrlichs analyze how overpopulation meanwhile depreciates the quality of life for everyone—through hunger, pollution or the spreading urbanization that breeds alienation, "potential assassins" and likely social breakdown.

The book seems weakest, however, on this unscientific question of quality of life. Surely some of the world's most populated places are among its happiest, and surely those urban ills are more the result of American cultural factors. There is a page on "aesthetic considerations" which argues for beautiful, varied environments on the basis that sensory stimulation has been found to increase brain size in rats.

Historically, population growth has been controlled more by the death than the birthrate—by famine, pestilence, continual war. The Ehrlichs suggest grim disasters in the next decades including some bizarre examples: Nuclear war eliminates developed countries; pollution so changes the heat balance that storm tracks shift, turning fertile lands to deserts; lethal agents escape from a biological warfare lab, or a Vietnam war veteran brings plague to rat-infested New York, or a specially virulent flu epidemic outraces production of vaccine.

But the Ehrlichs ask us to agree that controlling the birthrate would be more humane. And, trying to de-pollute the environment too, they present all conceivable measures from those already standard to those ruthlessly appropriate for a species fighting for survival: forced adoption or abortion of all illegitimate babies; sterilization of mothers after the second child; a new Constitution, an extra President, a new political party for the United States; repudiation of Judeo-Christian attitudes to nature and of economists' faith in production and consumption; reorientation of American values back to economy and thrift . . .

Internationally, the "overdeveloped" countries would concentrate on population control in the underdeveloped and "never-to-be-developed." They would also educate villages, supplying them with small television sets so that they might be taught the mistakes of industrial society: With an increasing G.N.P. as our aim "we have created a vast industrial complex and great mental, moral and aesthetic poverty." The underdeveloped should be semi-developed—as agricultural societies or as cultural or recreational resources for humbled Western man. Gradually world government should form—an Ocean Regime, an Atmosphere Regime, finally a Planetary Regime.

This may begin to smack of Total Planning, dictatorship and *1984*. The book is nevertheless as timely and important as it is provocative.

—Hazel Eagle

Looking for Dilmun
Geoffrey Bibby (Knopf, $10.00)

"Is there anything of interest to an archaeologist on Bahrain?" asks a reporter.

Geoffrey Bibby smiles—gently. "Yes," he says, recalling thousands of tumuli that dot the small island sheikhdom in the Persian Gulf. "There is the largest prehistoric cemetery in the world."

That was in 1953 when the British archaeologist and a team of Danes were digging up a Viking causeway in Jutland. For the next 15 years Bibby and a battalion that included a geologist, a surveyor, photographers, laborers, an artist, a historian, and—as Bibby dubs himself—"dirt-archaeologists" peeled the centuries from towns and tombs first on Bahrain, then up and down the Gulf shore of Arabia for a span of some 250 miles. They were looking for Dilmun, a vanished realm that once spread tentacles of trade between Mesopotamia and the early civilizations of the Indus Valley.

Geoffrey Bibby's story makes an absorbing detective yarn, but not one for beginners, in the intricate subject of archaeology. It would be better to begin on C. W. Ceram's *Gods, Graves and Scholars.*

Bibby got plenty of help from oil companies, sheikhs, and the Carlsberg Breweries, but precious little from the ancient Dilmunites. They reared no lofty ziggurats—those step-sided artificial mountains that enthroned city gods all over Mesopotamia—to show him where a city slept and guide him to its heart. They left no clay tablets to tell him how they worked, wed, warred and worshiped—or else they hid their libraries well.

They prospered when the inexorably rising slab of Arabia was still low and wet enough to fill their wells and sprout their seeds; now the wandering sand may well hide a Dilmunite Athens. They strutted onstage before Gilgamesh's day and off again after Abraham's, yet Bible texts that preserve a memory of Babylon, Sumer and Assyria breathe no hint about their neighbor, Dilmun. [Continued]

Come discover the insider's Africa on the SAS "Mini Safari"

Rendezvous with rhinos. Live it up with lions. Get to know a gnu. An SAS "Mini-Safari" whisks you in special Safari Vehicles through all that's most wild and wonderful in Kenya, Tanzania, Uganda. Gaze on parks teeming with game. Ngorongoro Crater. Mt. Kilimanjaro. Famed Murchison Falls. And—coming and going—get the bonus of a stop in wonderful Copenhagen.

Yes—Africa Calls. So come swing through Africa on this SAS "Mini-Safari". Weekly departures. 21 days from $1,652*. Mail our coupon for details.

*Based on 14/21 day ITX economy round trip air fare on SAS from New York to Nairobi via Copenhagen. Check your travel agent for prices through our other gateways.

S

SAS, Box 3443, Grand Central Station, New York, N.Y. 10017

Please send me your free folder on SAS "Mini-Safari" Tours.

Name

Address

City State Zip

My Travel Agent is

Let yourself go on safari on SAS
SCANDINAVIAN AIRLINES

The tablets of Mesopotamia do. But even so sharp a sleuth as Mr. Bibby can find scant clues to Dilmun in "situated, like a fish . . . in the midst of the sea of the rising sun. . . ." Yet clues are there, and we peer fascinated over his shoulder as he unravels them. "Like a fish" was Sumer's favorite metaphor for an island, and the sun, they felt, rose in the Persian Gulf. Not much to go on, but enough to go looking for Dilmun on Bahrain.

Mr. Bibby unfolds a long, digressive, yet enthralling tale as the search deepens through the strata of centuries. Searchers find Dilmun here, Dilmun there, Dilmun sprawling over an area at least the equal of Babylonia.

But if *you* ever go looking for Dilmun, try the "tell" (mound) under the old Portuguese fort on Bahrain. There seven cities and five millennia of history are stacked up in a rich layer cake of civilizations. And, says the author, "there would still be city here to dig if we dug a thousand years. . . ."
—*Pat McGorum*

The Smithsonian
invites your financial
contributions for general
support, research, programs
and endowment.

Life income trusts
and annuities can be
arranged, providing tax
advantages for you
while assisting the
Smithsonian Institution,
an independent educational
and scientific organization.

For additional
information, contact:

Director
Office of Development
Smithsonian Institution
1000 Jefferson Drive S.W.
Washington, D.C. 20560

Smithsonian

Highlights

Arts and Industries Building

In addition to the one-pound piece of Apollo 11 moon rock, an Early Bird Satellite—the operational backup model for the world's first commercial communications satellite—will be on display for an indefinite time.

"Polish Folk Art," a selection of costumes, wood carvings and decorative forged iron pieces, is here prior to a national tour.

"Dorothy Liebes Retrospective" shows the work of the famous textile designer over 30 years.

"Today and Tomorrow in Space" is a show of paintings by Robert McCall; the subjects include the NASA space program and the movie *2001*.

"Vibrating World," opening August 22, uses black-and-white photographs to explain cymatics—the structure and dynamics of waves and vibrations. The exhibition is being circulated across the country by IBM.

Museum of History and Technology

"Laser 10," the history and application of laser technology during its first ten years, is here until Labor Day.

"*Manhattan*'s Voyage" traces the historic trip of the *U.S.S. Manhattan* when it became the first commercial vehicle to negotiate the Northwest Passage. The display includes a film, still pictures and a model of the ship.

"Gandhi Memorial," a photographic exhibit on Gandhi's life, will open August 15. It will include a photographic essay on faces of India as well as a display of Indian crafts.

"Confetti" is the name of the current production of the Smithsonian Resident Puppet Theatre. It will continue through September 17.

Museum of Natural History

"Indian Images" consists of photographs of North American Indians.

"Reptiles," another photographic show, will continue on display into the second week of September.

National Portrait Gallery

"Along This Way," a teaching exhibition on black-culture exponent James Weldon Johnson (1871-1938), uses portraits, photographs and recordings to tell about the man and his work.

A selection of sculpture from the Gallery's permanent collection will be on display all summer.

Note: The collection of the Museum of African Art will be at the Portrait Gallery into early September.

National Collection of Fine Arts

"Artists Abroad" is a selection of 50 paintings and sculptures by Americans who studied abroad with the Institute of International Education.

A Winslow Homer exhibition includes 51 oils, watercolors, drawings and graphics from the artist's popular early period. Most of the works are on loan from a sister Smithsonian art museum, the Cooper-Hewitt Museum of Decorative Arts and Design in New York City.

The "Thomas Nast Show" consists of five paintings from the artist's Grand Caricaturama.

Traveling Exhibition Service

Some of the Smithsonian exhibits that will appear throughout the country during August are:
Detroit, Michigan—"Henry O. Tanner Paintings" (Detroit Institute of Arts, to August 30).
New Orleans, Louisiana—"Armand Hammer Collection" (Isaac Delgado Museum of Art, August 15 through September).
Davenport, Iowa—"Contemporary American Black Artists" (Davenport Municipal Art Gallery, August 8 to September 6).
Louisville, Kentucky—"Paintings by Carl-Henning Pedersen" (The J. B. Speed Art Museum, July 25 to August 23).
Mankato, Minnesota—"Recent British Prints" (Lincoln Art Gallery, Mankato State College, July 18 to August 16).
Oklahoma City, Oklahoma—"Georgian Country Houses" (Oklahoma Art Center, July 18 to August 16).
Pittsfield, Massachusetts—"British Designer Craftsmen" (The Berkshire Museum, July 18 to August 16).

Smithsonian Museum Shops

"American Indian Crafts," both traditional and contemporary craft work by Indians from various tribes around the country, is at the Museum of History and Technology shop.

"The Arts of the South Pacific" will be at the Arts and Industries Building shop until the end of August. It includes carvings and crafts of islanders from New Guinea, New Britain and New Ireland—examples of remarkable primitive art.

Foreign study tours . . .

The foreign study tours listed below are currently being planned exclusively for members of the Smithsonian Associates. Members wishing to receive further information should write to the Smithsonian Associates Reception Center, Great Hall, Smithsonian Building, Washington, D.C. 20560, specifying which tour or tours are of interest.

Decorative Arts and Textiles of England: Visits to outstanding private and public collections, with emphasis on needlework and weaving, in and about Oxford, London and the Cotswolds. Lectures and workshops will be offered under the guidance of Mrs. W. L. Markrich, an outstanding international authority on needlework. Leave September 10, 1970, for two weeks, with a third week free for participants to arrange their own travel in Europe.

Opera in Italy and Sicilian Archaeology: A combination tour offering good seats and backstage visits to the opera houses of Rome, Milan, Naples, Venice, Trieste, Catania and Palermo, along with an introduction to the Greek archaeological sites of Sicily. Mrs. Loudon Mellen of the Washington Opera Society and Dr. Richard Howland of the Smithsonian staff will conduct. Leaves mid-February, 1971, for three weeks.

East African Safari and Indian Ocean Cruise: A five-day visit to the great game preserves of Kenya and Tanzania, followed by a two-week cruise to Aldabra and other of the Seychelles island group from and to Mombasa. Dr. George Watson, chairman of the Department of Vertebrate Zoology at the Smithsonian's Museum of Natural History, will conduct March 20 to April 15, 1971.

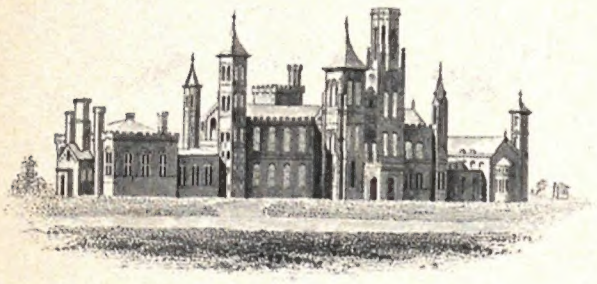
Asiatic Turkey: A tour of Hittite archaeological sites in central Turkey and the better known classical excavations in western and southern Turkey. The itinerary will be planned for short trips out of Ankara, Alanya and Izmir, with comfortable hotel accommodations. Mr. John J. Slocum, staff member of the Smithsonian's Museum of History and Technology and trustee of the Archaeological Institute of America, will conduct. The tour is planned for late spring of 1971.

Palladian Architecture in Ireland: Visits to private estates and public buildings, with seminars on preservation techniques and methods, in cooperation with the Irish Georgian Society. Dr. Richard Howland of the Smithsonian and The Honorable Desmond Guiness of the Irish Georgian Society will conduct. May 31 to June 15, 1971.

Russian Art and Architecture: An unusual tour of the USSR that includes Armenia, Samarkand, Kiev, Vladimir and Novgorod, as well as extended visits to Moscow and Leningrad. Will emphasize museums, archaeological sites and historic buildings restoration projects. September 20—October 12, 1971.

. . . for Smithsonian Associates

The view from the castle



Smithsonian Tropical Research Institute,
off to a shaky start 47 years ago,
adds a vital dimension to ecological studies

To anyone used to the milieu of academic meetings the following has a familiar ring: "It began in a drab, bickering meeting of scientists in Washington, and was followed by the organization of an 'Institute' which existed only on paper and which apparently was unlikely ever to serve a useful purpose."

So wrote Professor Thomas Barbour of Harvard in his autobiographical *Naturalist at Large*. In 1923 Barbour with a group of friends persuaded Governor Jay Johnson Morrow of the Panama Canal Zone to set aside the island of Barro Colorado in Gatun Lake as a unique biological laboratory preserve of 3,600 acres.

Under James Zetek, an entomologist in the Canal Zone, the laboratory began at once to flourish, supported by personal donations of Barbour, David Fairchild and others, eventually by annual "table fees"—subscriptions paid by institutions such as the Smithsonian, Harvard and other universities, the Eastman Kodak Company and the Carnegie Institution. With a mild climate, free of malaria and dysentery, small laboratory and living quarters set in this island habitat containing over 7,000 species of plants and animals, Barro Colorado became the New World's foremost natural tropical laboratory.

In 1940, in consideration of its great value to science, the U.S. Congress set aside the Canal Zone Biological Area and authorized an annual appropriation of $10,000 to support this station. No money was forthcoming, but private fees and donations continued. By a fortunate coincidence Alexander Wetmore became the sixth Secretary of the Smithsonian in 1945. Wetmore is a scientist's scientist, for many years the premier ornithologist of the United States, member and medalist of more than two-score scientific societies, author of more than 700 scientific papers, as well as of *The Birds of the Republic of Panamá*. The third volume of this great opus Wetmore is even now completing. Dr. Wetmore foresaw the necessity of continuing the Smithsonian's tropical investment. In 1946 under a government reorganization plan, President Truman obtained a permanent home for the Canal Zone Biological Area within the Smithsonian Institution framework.

What a prescient group it was that set aside Barro Colorado. Much of the pioneer work in tropical American ecology has been started there, beginning with W. C. Allee's measurements of the physical factors of the environment, and L. A. Kenoyer's work on succession in a tropical rain forest. Frank Chapman, Alfred Emerson, Alexander Skutch, Laurence Irving, Ralph Buchsbaum, T. C. Schneirla and Emmet Dunn have all worked there.

How proud Tom Barbour would be to see his handiwork today—now called the Smithsonian Tropical Research Institute—under the effective directorship of Dr. Martin Moynihan. This first U.S. government-supported tropical study center in the world now harbors five laboratories studying marine and terrestrial ecology from seashore to high mountains, with a record of about 2,000 published scientific research papers.

S. Dillon Ripley

Photograph and design by Heikki Ratalahti

Reach out and experience a new world

Advertisement

Think back to what fun it all was —your first cactus, first rainbow, first turtle. The surprise! The thrill! The wonder!

Can new experiences like these continue on into adulthood? *Smithsonian* says aye! Thumb back through the pages of this issue—any issue—and count up the new worlds you've been touching on. Man. His environment, sciences, arts, adventures, follies, fortunes. Nature. Her creatures, colors, shapes, phenomena, laws, mysteries.

Since 1846 the Smithsonian Institution has been in the business of linking man with the universe he inhabits. Now, our new magazine offers you the opportunity to bring first experiences into your home regularly.

A year's Charter Membership is just $10. In addition to twelve issues of *Smithsonian,* you get the tangible and welcome benefits listed at the right. You receive an intangible reward, too:

The dues you pay, so nominal, help make possible research and educational activities without parallel anywhere else in the nation. Activities that help boys and girls understand in addition to helping *you* know more about your world. Give the Smithsonian your support . . . Mail the membership application bound in opposite.

Charter Membership brings you these benefits and privileges

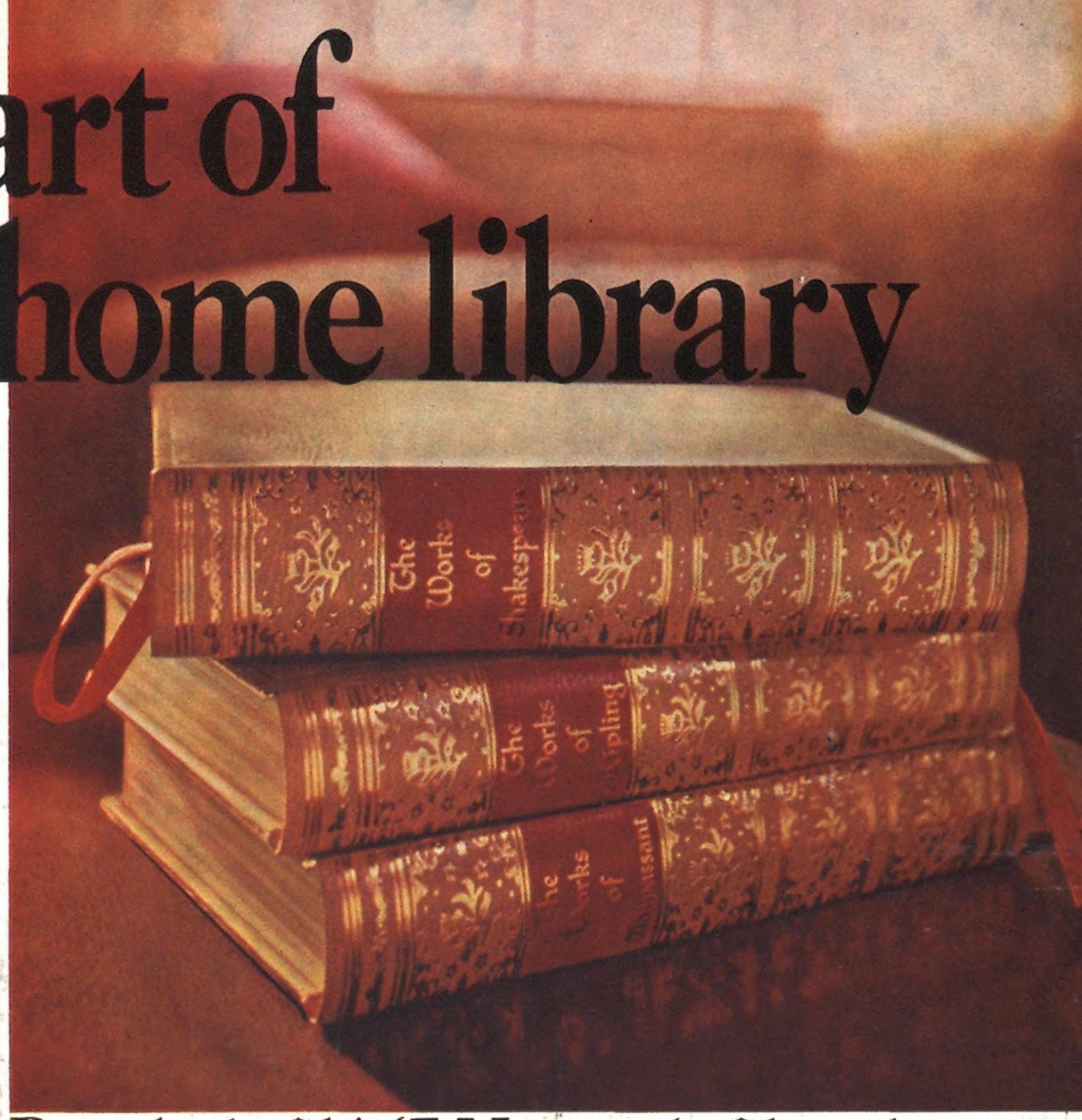
SMITHSONIAN is published monthly for members only. In addition to a full year's subscription, you receive as a National Associate:

Travel benefits. Immediately upon election you are eligible for Smithsonian group tours.

Book and gift discounts. On all books published by the Smithsonian Press, you get a 20% discount. On books from other publishers, 10%. You also get 10% off on all gifts purchased by mail or in person from the seven Smithsonian shops. Book and gift offerings are announced regularly in SMITHSONIAN.

Preferential reception. An attractive lounge in the historic Great Hall of the original Smithsonian Building is set aside for the use of your family whenever you visit Washington.

The start of a fine home library



Regularly $14.67. Now only $1 each.

Let us send you, for the token price of only $1 each, three books that have served as cornerstones in many a fine home library.

The complete works of Shakespeare

This beautiful 1300-page volume contains every word Shakespeare ever wrote. All 37 of his comedies, tragedies, and historical dramas including Hamlet, Romeo and Juliet, Macbeth, etc. Also all of his poems and sonnets.

The works of Kipling

Actually eight books in one. A complete novel and 139 stories, ballads and verses loved the world over, including Mandalay, Gunga Din, The Phantom Rickshaw, etc.

The works of De Maupassant

128 matchless tales by the acknowledged master of the short story. Every story complete and unexpurgated: The Diamond Necklace, A Piece of String, The Will, etc.

Each volume is clothed in a handsomely-tooled binding of antique ecru with both the elegant look and feel of leather.

You will enjoy reading these books, just as millions before you have. Your friends will admire them, perhaps even envy you for owning them. And your children will gain a real advantage with books like these always close at hand.

We offer you three books of this calibre for only $1 each to introduce you to our new Golden Giants Series. We think you will be impressed. And we hope you will want to own others in the Series, as they become available, including:

Hugo. 36 complete works including Hunchback of Notre Dame, A Woman of the Streets, The Souls.

Stevenson. 39 novels, stories, poems. Treasure Island, Dr. Jekyll and Mr. Hyde, Kidnaped, etc.

Doyle. All the best of Sherlock Holmes—The Sign of The Four, Red-Headed League, plus other works.

Poe. 91 works: Annabel Lee, The Raven, The Gold Bug, Murders in the Rue Morgue, etc.

The full series will also include the works of Cellini, Wilde, Ibsen, Browning, Longfellow, Emerson, Dostoevsky, Byron and many others.

Normally, you would expect to pay $10 each or more for deluxe editions of books like these. But our direct-to-the-public method of book distribution (which we have specialized in for over 30 years) lets us make these volumes available for only $4.89 each, plus a few cents postage.

Send no money now. Simply mail coupon to get your first three volumes for only $1 each, plus postage, and to reserve the privilege of examining future volumes as they come from the press.

You will receive advance description of all upcoming volumes. You may reject any book before or after you receive it. And you may cancel your reservation any time you wish.

Black's Readers Service, Roslyn, New York 11576.

Black's Readers Service 0-JV
ROSLYN, NEW YORK 11576

Please reserve for me the beautiful volumes in the new Golden Giants Series. For no money in advance, send me the first 3 now: SHAKESPEARE, KIPLING and DE MAUPASSANT. A week after delivery, I will either return them and owe nothing, or keep them for $1 each, plus mailing.

Then, as they are printed, I will receive additional volumes on approval, for $4.89 each, plus mailing. I will get advance descriptions of future books. I may reject any book before or after delivery. And I may cancel my reservation any time. (Books shipped in U.S.A. only.)

MR. / MRS. / MISS _____
(Please print plainly)

ADDRESS _____

CITY & STATE _____ ZIP _____

GG1-489